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Dr. Günther, FRS.
from his friend
the Author.

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

SUPPLEMENT No. V.

PAGES 1—18; PLATES I & II.

DINOSAURIA (IGUANODON).

[WEALDEN AND PURBECK.]

BY

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ETC. ETC.

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SUPPLEMENT (No. V)

TO THE

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF

THE WEALDEN AND PURBECK FORMATIONS.

(IGUANODON.)

§ 1. MANDIBLE AND MANDIBULAR TEETH. Plate I, figs. 1, 8.

THE dentary element of the right mandibular ramus of the young Iguanodon ('Monograph on Wealden Reptilia, *Dinosauria,* IGUANODON,' part, ii, Plates XI, XII),[1] discovered in the Wealden of Stammerham, near Horsham, Sussex, by G. B. HOLMES, Esq., demonstrated the fact that the sculptured surface of the crown in the teeth of the lower jaw was turned inward, the smooth surface outward, toward which aspect the entire tooth was moderately bent. Moreover, the alveoli in that jaw showed eighteen teeth to be the number supported in a close-set series and working position in the dentary element (ib., ib., p. 22).

The portion of mandible obtained by S. H. BECKLES, Esq., from the locality of the limb-bones described in 'Supplement' No. IV,[2] is also the dentary element of the right ramus, of which a figure of the inner side is given in Plate I. On this surface the crowns of seven teeth nearly risen into place are seen; the worn crown and fang of a few of the preceding generation of teeth (*a, a*) have been preserved, and the summits of the crown of a few teeth of a third set (*c*) in succession are seen in the interspaces of the more developed teeth of the second set (*b, b*).

The length of the portion of mandible here preserved is eighteen inches; that of the corresponding part of the mandible of the Iguanodon discovered by Captain BRICKENDEN in the Wealden of Tilgate (ib., ib., Pl. XIII) measured 20 inches. It is probable, therefore, that Mr. Beckles' specimen had nearly attained the full average size of the great herbivorous reptile.

The antero-posterior breadth of the teeth rising into place averages 9 lines; the largest mandibular teeth of Iguanodon (ib., ib., Pl. XVIII, figs. 3, 3 *a*) give 1 inch

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[1] Pal. Soc. Vol. for year 1854.

[2] Ibid. 1871.

3 lines in the same dimensions. The crown-germs of the teeth in the Stammerham jaw (ib., ib., Pl. XI) average 6 lines; we thus learn that each successive series of teeth had an increase of size corresponding in a general degree with the growth of the jaw.

The subject of fig. 1, Pl. I, of the present Monograph shows at its interior or symphysial end the abrupt slope downward of the short, edentulous, compressed part, which curves inward to meet the corresponding part of the opposite ramus at a short symphysis, extending along an horizontal surface, parallel with the straight lower border of the mandible. The smooth canal thus formed above the symphysis indicates a relation of facility in regard to the movements of protrusion and retraction of a long, cylindrical, muscular tongue, probably used, like that of the Giraffe and Megatherium, for the prehension of the vegetable substances selected by the Iguanodon for food. It is a generic mandibular character.

The commencement of the coronoid process, contributed by the dentary, is the same in extent as that shown in the younger Iguanodon's jaw (ib., ib., Pl. XI, *a, f*), and indicates the position of the suture of the dentary with the surangular element.

The surface of the tooth-crowns here exposed shows the submedian primary vertical ridge, which, in detached teeth, indicates the hinder border of the crown by its proximity thereto. The secondary ridge is less strongly marked, and is best shown in the hindmost teeth. The anterior lamello-serrate border describes the usual convex curve; the posterior border being almost straight along its chief extent. The dental characteristics of *Iguanodon Mantelli,* as illustrated in previous plates (ib., ib., Pl. XVIII, Supplement, No. III, 'Iguanodon,' Pl. X),[1] are well maintained. The secondary ridge is, however, less developed than in the larger teeth of older Iguanodons. The alveolar border here, as in the smaller jaw (Pl. XII, fig. 3), describes a gentle sigmoid curve in the transverse direction, the convexity being inward in the hinder two thirds, then straight or slightly concave to the commencement of the symphysial slope. Three generations of teeth, *a, b, c,* are exposed in the present mandibular fossil (Pl. I).

In the inwardly convex part of the alveolar tract the teeth are placed 'en echellon;' the fore-and-aft plane of the anterior tooth (Pl. I, fig. 1 *b*), if carried back, would pass outside the succeeding tooth, and the crown of this stands in like relation to the next tooth behind. Thus, when fully in place, the crowns slightly overlap in the lower as in the upper jaw ('Monograph on Iguanodon,' Part No. I, Plate XI, fig. 2),[2] and eighteen teeth may range along an alveolar tract, which, if each tooth stood clear of the next, would not support more than fourteen. Room is also got for the full number along the working line by a certain alternation in the degree of attrition, as is well exemplified in the portion of mandible of a younger or smaller Iguanodon next to be described (Pl. I, fig. 8).

Three views of an upper tooth (Pl. I, figs. 2, 3, 4) and three views of a lower tooth

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[1] Pal. Soc. Vol. for year 1862.

[2] Ibid. 1854.

(ib., figs. 5, 6, 7) are taken from teeth of the same individual as that to which belonged the mandible (fig. 1) and the bones of the fore-foot described in 'Supplement,' No. IV.

I am indebted to A. J. Hogg, Esq., for the opportunity of examining and figuring the instructive specimen (Pl. I, fig. 8). It was discovered in the hard limestone, locally known as the "Under Feather," which is situated from four to five feet below the accumulation of shells of *Ostrea distorta,* called the "Cinder Bed," in the Middle Purbecks.

A reference to p. 22, fig. 4, of my 'Monograph on the Fossil Mammalia of the Purbeck Formations, British Mesozoic Mammals' (Palæontographical Society, vol. xxiv, issued for 1870), will show the position of the Middle Purbeck series in which the present interesting evidence of the Iguanodon was entombed. It is the first example of that genus, to my knowledge, from the Purbeck series.

In making this statement I refer, of course, to the unequivocal evidence of Iguanodon afforded by the dentition. A large phalangeal bone is figured by Buckland in Pl. XLI, 'Geological Transactions,' Second Series, as a "metacarpal" of Iguanodon. It was picked up "on the sea-shore, about half a mile north of the village of Swanwich" (ib., p. 428), and though "more or less injured by rolling on the sea-shore" has most claim to be referred to the hind-foot of the Iguanodon. It was most probably washed out of the cliffs of iron-sand and sandy clay described by Webster as dividing the Greensand of Ballard Down from the upper body of the Purbeck "limestone."

The portion of jaw here exposed (Pl. I, fig. 8), is the dentary element of a right mandibular ramus, about the size of the Stammerham specimen (Monogr. cit., vol. for 1854, Plates XI, XII), but is mutilated at both ends; it includes, however, in an alveolar tract of four inches, ten teeth, alternately young and old. The foremost, *b*, is a lanceolate and acuminate crown-germ, least advanced in size and lowest in position in the jaw. The second, *a*, is fully in place with the upper third of the crown worn away and supported by a long, slender, tapering fang, occupying the interspace between the first and third teeth. The latter shows the crown fully formed, with the apex risen almost to the level of the worn surface of the antecedent tooth, between which and the fourth it accurately fills the interspace. The fourth tooth, *a*, rises to a higher level than the second and has rather more of the crown worn away; much of its narrow fang is exposed. The crown of the fifth tooth—third of its series, *b*—fills, like the third tooth —second of the series *b*—the interval between the fangs of the fourth and sixth teeth. The sixth tooth rises a little higher than the fourth, and is rather more worn. The seventh tooth—fourth of the series *b*—is more complete and rises higher than the fifth or third; the apex of its crown is on a level with the worn surface of the sixth tooth: the outer part of the lower half of the crown and beginning of the fang of the seventh tooth has been broken away, showing the pulp-cavity in the latter. The eighth tooth—fourth of the series, *a*—is worn down to the contracted base and beginning of the fang. The ninth tooth has risen above it, has come into service, and the crown is supported by a strong root. Beyond this is part of the crown of a successional tooth of a third series, *c*.

The close interlocked fitting of these teeth of different stages and periods of growth is most instructively shown in the present specimen; former ones had given only a partial view of this arrangement, suggestive, however, of an Iguanodontal character of dentition, which is here demonstrated.

The primary and secondary ridges are more equally developed, and the tertiary ridges less conspicuous, in these lower teeth of a Purbeck *Iguanodon* than is usual in the larger or older Wealden specimens. If any Palæontologist should see in this a specific character he may, perhaps, accept the name of *Iguanodon Hoggii*.

§ 2. Skull and Teeth of *Iguanodon Foxii*. Plate I, figs. 9, 9 *a*, 10; Plate II, figs. 1, 5, 8—18.

This section of the present Monograph may be regarded as a Supplement to the paper by Professor Huxley, F.R.S., F.G.S., in the 26th volume of the 'Quarterly Journal of the Geological Society,' p. 3, Pl. I, figs. 1—4 (1870), in which its chief subject has been described and figured with characteristic care. The conclusions of the author as to the generic relationship of the species to which this unique fossil skull belonged, were not, however, satisfactory to its discoverer, and he, consequently, placed the specimen in my hands.

The desirability of throwing light upon the cranial characters of Iguanodon, supposing it should be admitted that there may be here a source of such, will serve, I trust, as an excuse with palæontologists generally, for my presuming to go over ground already trodden by so able a predecessor, and the result may be that the Rev. W. Fox will not stand alone in rejecting the ascription of his fossil to a genus "*Hypsilophodon*."

The articular or condylar part of the basi-occipital (Pl. II, fig. 1, 1) is broken away, a portion of the broad basilar part of the bone (ib., fig. 5, 1) remains in articulation with the basi-sphenoid (ib., ib., 5). This element shows a median contraction with lateral emarginations, bounded anteriorly by the pair of pterapophyses (*t*, *t*). The left of these abuts in its natural position against the corresponding pterygoid, the hinder branch of which, diverging obliquely backward, is broad and moderately concave on its postero-internal surface; the end which would have abutted upon the inner and back part of the tympanic is broken off. There is no apparent "pre-sphenoid style" from the interspace of the pterapophyses.

The left half of the foramen magnum (Pl. II, fig. 1 *f*) is entire, showing a vertical diameter of 4 lines, a transverse one of 5 lines; the lower part shows the fractured surface from which the left exoccipital portion of the occipital condyle has been broken away: the basi-occipital part of the condyle is wanting. The super-occipital (ib., ib., 3) rises broadly and vertically from the upper half of the foramen, *f*, for an extent of 6 lines; a tract of matrix of 3 lines extent intervenes between the super-occipital, which here shows a jagged upper margin, and the hind border of the parietal, 7. It may be, as in *Varanus* (ib., fig. 2), that an unossified tract of the cranial walls has been left here; or an angular ridge, as in the Crocodile (ib., fig. 4, 3), may have been broken away. The direction of the occipital surface is more vertical than in Lizards. The mid-tract of the super-occipital is moderately convex transversely, the lateral tracts as moderately concave to the lateral borders of the occiput, which borders gently converge as they rise (Pl. II, fig. 1, 3). The exoccipitals (2) extend, connately with the par-occipitals (4), outward, slightly downward and backward, for an extent of 9 lines from the foramen magnum, preserving a vertical breadth of 4 lines.

In *Iguana* (Pl. II, fig. 3) the super-occipital (3) is a vertical crest, from which the sides slope forward and outward at an acute angle. In *Varanus* (ib., fig. 2) the super-occipital surface (3) is transversely convex and strongly inclined from the foramen magnum (*f*) upward and forward. The small Dinosaur, like *Dicynodon*, shows a crocodilian type of the occiput.

The left tympanic (ib., fig. 1, 28) has been dislocated inward, and lies with its upper end beneath the par-occipital abutment (4).

The pterygo-palatine structures accord with the lacertian type. The proportions of the pterapophyses (ib., fig. 5, *t*) are more like those of *Varanus* (ib., fig. 6, *t*) than of *Iguana* (ib., fig. 7, *t*); but the pterygoid of the small Dinosaur resembles that bone in the herbivorous Lizard. The right pterygoid (fig. 5, 24) retains part of the tympanic process (*a*) and of that (*c*) which abutted against the ectopterygoid (25); a portion of the right palatine (20) is preserved, of small size, showing an anterior and posterior emargination, as in *Varanus* (ib., fig. 6, 20). The hind end of the right maxillary with the abutting part of the ectopterygoid are broken away in the fossil. The right malar bone has left its impression on the matrix (Pl. I, fig. 9, 26).

The masto-postfrontal zygoma (ib., 8—12), in its breadth and relative position to the occiput and parietal, is crocodilian. The normal or lower (malo-squamosal) zygoma is indicated on the right side by the impression of the malar and a remnant of the squamosal; a larger proportion of which is preserved on the left side (Pl. II, fig. 1, 27) abutting against the tympanic (ib., 28). It is also shown in Pl. I, fig. 9 *a*, where the parts are drawn without reversing. The upper outlet of the temporal fossa is smaller than in Lacertians, larger than in existing Crocodiles; its proportions are those of some Teleosaurs and Dicynodonts, and are approached by those of the small Crocodilian from the same Wealden locality (ib., fig. 24, *t*, *t*).

The skull of *Scelidosaurus*, which gave the first considerable insight into the type of that part of the Dinosaurian skeleton, had, unfortunately, lost so much of the fore-end as prevented the application of the external narial test of its correspondence with one or other of the two existing divisions of Brongniart's *Sauria*. It could not, thereby, be determined, for example, whether the outer part or process of the fore-end of the nasal applied itself to the anterior edge of the ascending process of the maxillary, or to that of the premaxillary; in other words, whether the maxillary entered into the formation of the outer nostril, as in *Lacertilia*, or was excluded therefrom, as in *Crocodilia*.

The present Dinosaurian skull supplies this test and shows its correspondence with the Crocodiles; there is, nevertheless, a touch of the Lizard. For the body or jaw-part of the premaxillary (Pl. I, fig. 9, 22) sends upward not only the process from its hinder part (22^x), applying itself to the outer border of the fore-part of the nasal (15) and excluding therefrom the maxillary (21), but it also sends upward a more slender process from the fore-part, which terminates in a point wedged between the ends of the nasals and dividing the right nostril (*n*) from the left, after the lacertian type. Yet, again, the Crocodilian affinity is here manifested, for the premaxillaries are not confluent and the dividing process is not a single and symmetrical one, as in *Iguana*, *Varanus*, and most Lizards,[1] but is bisected by the medial suture or cleft dividing the right from the left premaxillary. The premaxillary thus, in the main, adheres to the type of that of the Crocodile, circumscribing all that part of the nostril which is not due to the nasal bone itself, and excluding the maxillary from the boundary of the respiratory opening. The application of the outer process of the fore-end of the nasal to the anterior edge of the ascending process of the maxillary[2] could only be predicated by one mistaking a crack of the premaxillary for the suture. The ascending process (Pl. I, fig. 9, 22^x) with which the nasal articulates at the outer part of its fore-end belongs to the premaxillary as well as does the inner process of the same end of the nasal bone.

The premaxillo-maxillary suture extends from behind the sixth obvious premaxillary tooth for the extent of nearly an inch, with a slight curve convex forward, between the two main elements of the upper jaw. The maxillary and premaxillary have been slightly separated from each other along this suture by the force which has fractured both bones; but the margins of the suture show its true nature and distinguish it from the fractures, especially those on the body of the premaxillary, one or other of which must be adopted for a suture on the hypothesis of the hinder ascending process (22^x) belonging to the maxillary bone.

Of the six premaxillary teeth in place the foremost alone (Pl. I, fig. 9, *i*) has the crown entire; its outer surface is convex across and lengthwise, most so along the middle, transversely, the main or mid-ridge of the Iguanodontal teeth being thus indicated. The margins are also slightly relieved (Pl. II, fig. 18, magn.) and converge at an acute angle to a sharp, slightly incurved, apex; the enamel is minutely punctate. Neither in the right nor the left deflected part of the premaxillary, anterior to the pointed tooth, is there any trace of socket or fang. It would seem that this end of the premaxillaries was edentulous, like the corresponding slope of the symphysial part of the mandibular rami to which it was applied. The outer surface of the deflected ends of the premaxillaries is pitted and finely punctate or rugose.

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[1] *Hatteria* (*Rhynchocephalus*) is an exception ('Phil. Trans.,' 1862, plate xxv, fig. 5, 22, p. 467).

[2] "The outer, in like manner, applies itself to the anterior edge of the ascending process of the maxillary and forms a part of the outer boundary of the nostril."—Huxley, ut supra, p. 4.

The fractured bases of the premaxillary teeth succeeeding the first show a transverse diameter nearly eqnal to the fore-and-aft one, and I can form no judgment as to the shape of their missing crowns, save on the analogy of the Iguanodon. They are close-set, and if those crowns extended antero-posteriorly they must have overlapped. This Iguanodontal arrangement is demonstrated in the undisturbed maxillary teeth, of which eight are recognisable; the hind border of one crown overlaps the fore border of the tooth behind.

The two anterior maxillary teeth have slipped in part from their sockets and do not show this arrangement. The first is the smallest antero-posteriorly, but its crown has been worn to the fang, and when entire would be larger in that direction. The second tooth is less worn, and yields in size to the third. In the fifth the full size of the crown, antero-posteriorly, is shown, and this tooth is selected for the magnified view in Pl. I, fig. 10.

The outer surface of the crown is bisected by a medial primary longitudinal ridge; behind this ridge the surface is smooth and concave transversely; in front of the ridge the similarly concave surface is accentuated by two low secondary longitudinal ridges. The same characters appear, in the degree in which the crown is unworn, in the other maxillary teeth.

In upper or maxillary molars of *Iguanodon Mantelli* the following varieties have been recognised and figured.

In the 'Monograph on the Iguanodon' (Palæontographical Society's volume for 1854, issued 1855, Pl. XVIII, fig. 2) the primary ridge is nearer the fore border of the crown than in fig. 10, Pl. I, of the present Monograph; there is a feeble indication of a secondary ridge on the anterior transversely concave facet. There are two secondary ridges in the posterior facet, as in fig. 10, and the crown is so worn down as to show no trace of marginal serrations.

In the upper tooth, fig. 1, Pl. XVIII (Monograph cit.), the crown is less worn and the marginal serrations appear beyond the line of extreme breadth. The anterior facet shows no secondary ridge; the two such ridges in the posterior facet run together in the terminal part of the crown.

In the 'Monograph on Iguanodon, Supplement No. II' (Pal. Vol. for 1858), "Cretaceous Reptilia," Pl. VII, fig. 2, three upper molars are shown *in sitú* with the Iguanodontal overlap, viz. the hind border of a fore-tooth (*m*) over the fore-border of the next tooth (*n*): in these upper molars the primary ridge is sub-medial, and the front face smooth as in fig. 10, Pl. I, of the present Monograph; the two secondary ridges on the hind facet are feebly indicated. The marginal serrations are shown in the preserved terminal part of the crown, which is entire in the teeth marked *n* and *o*. Bisect the tooth *n* at the line at which it is worn away in figs. 9 and 10, Pl. I, and no serrations would appear. In some upper molars of Iguanodon the margino-serrate character is continued in a minute form nearer to the base of the posterior margin. I have figured a left upper molar of this variety in figs. 2, 3, 4, of Pl. I, and also to show the further variety of three secondary ridges on the hind facet of the crown.

But the upper molars in the subject of fig. 9 show, as in the enlarged view (fig. 10), a continuation of the relieved or raised lateral borders across the base of the crown, in a curved course, convex toward the fang. This basal ridge does not project beyond the origin of the primary ridge, but falls into that origin.

I have not observed this character, at least so definitely marked, in any upper tooth of *Iguanodon Mantelli*, and I regard it as indicative of a specific distinction of the smaller Iguanodon now under review, believing myself entitled to conclude as to its generic relationship from the characters of the dentition of the upper jaw above defined and illustrated.

It is true that one, at least, of the premaxillary teeth is canine-like with a crown "lanceolate and acuminate." But no portion of the skull of *Iguanodon Mantelli* has yet been discovered which would supply the means of testing its resemblance to or difference from the smaller species, in regard to this dental character. Consequently, prior to our knowledge of the skull and dentition of the smaller species, the discovery of a tooth answering in size to the ordinary upper molars of *Iguanodon Mantelli*, but with a "lanceolate and acuminate crown," would naturally suggest its reference to some other Dinosaurian genus of the Wealden, of the bulk of the Iguanodon. In giving a description of this tooth in the 'Supplement on Wealden Reptilia,' in the Palæontographical volume for 1857, issued in 1859 (p. 42), I therefore suggested that it might belong either to *Cetiosaurus* or *Pelorosaurus*. I now, however, from its resemblance to the entire premaxillary tooth in the small Iguanodon—as close as is the resemblance in the maxillary teeth—deem it more probably to belong to the larger species and to be a premaxillary tooth of *Iguanodon Mantelli*. As such, two views of this tooth of half the natural size are given in Pl. II, figs. 19 and 20, for comparison with the magnified view of the laniary of the smaller species (fig. 18). The surface of the crown (fig. 20) which answers to the outer one in fig. 18, and in *i*, fig. 9, Pl. I, is convex both lengthwise and transversely, and most so in the latter direction along the middle part; the main or mid-ridge of the maxillary Iguanodontal teeth being thus represented. On the opposite (inner) side of the crown (fig. 19, Pl. II) the surface is concave across the two thirds next the apex. One margin, the anterior according to the analogy of the small Iguanodon, is convex, the hinder margin along its terminal half is slightly concave. The crown expands antero-posteriorly above the root to nearly midway to the apex, towards which the borders then converge to a point with the different contours above noted. Both borders are trenchant, not serrate.

Now that we know that a laniariform, or 'lanceolate and acuminate,' premaxillary tooth was associated with molars of the Iguanodontal type, in a small exemplar of the genus, we may anticipate that the premaxillary part of the skull of *Iguanodon Mantelli*, when discovered, will show teeth, if they should be preserved there, of the laniary type exemplified in Pl. II, figs. 18, 19, and 20. The anterior mutilation of the skull of the *Scelidosaurus*, with maxillary teeth having the terminal and more expanded half of the crown serrate (Pl. II, fig. 21), precludes, at present, the determination whether the iguanodontoid molars of this genus were similarly associated with anterior laniaries. But the dentition of the small Purbeck Dinosaur (*Echinodon*), with a corresponding type of maxillary dentition (Pl. II, fig. 22), does include one or more laniaries in advance of molars of the serrate type, as in the small and large Iguanodons ('Monograph on the Fossil Reptilia of the Cretaceous and Purbeck Strata,' Pal. Soc. vol. for year 1858, p. 35, Pl. VIII, figs. 1, 1 *a*).

I next proceed to determine how far the dentition in the small skull repeats the iguanodontal character of overlapping arrangement of the crowns of the teeth.

The right tympanic and mandibular ramus are wanting in the fossil. The left mandibular ramus has been pushed obliquely to the right side, and its fore end has partly displaced the first and second molars, beyond which the projecting end has been broken away. The crowns of those teeth, so driven out of line, are thereby partly withdrawn from their sockets, so as to expose the basal half of their fangs. From this I infer that the force has operated upon the recent animal: for, if it had acted subsequent to fossilisation, through movement of the matrix, it would have broken the teeth, at that time cemented to their sockets. Howsoever that may be, displacement is obvious, and no inference can be drawn as to the original relative position of the crowns of these anterior teeth. As it is, the anterior edge of the crown of the third molar does not overlap in the slightest degree the posterior edge of the crown of the tooth before it; the reverse is the case if any overlap at all can be predicated.[1] In the undisturbed molars the hind edge of each tooth projects a little beyond the fore edge of the one behind it. This is the characteristic arrangement of the upper or maxillary teeth of *Iguanodon*. It is exemplified in the specimen figured in my second 'Supplement' to the Monograph on the genus (Palæontographical Society's volume for 1858, issued 1860), Pl. VII, fig. 2, in the undisturbed upper teeth, there marked *m*, *n*, *o*. The overlap by the anterior edge of the crown in the anterior four maxillary teeth of the posterior edge of the tooth in front, and the reverse arrangement in the rest of the maxillary series, where "the overlap seems to have taken place in the opposite direction," may be a character of *Hypsilophodon*, Huxley, but is certainly not a character of the present nor of any previous evidences of *Iguanodon*. In the small species discovered by Mr. Fox, as in the large type of the genus, the maxillary grinders not merely seem to overlap, but do so, in the way and degree exemplified in fig. 9, Pl. I, and in fig. 2, Pl. VII, of the former Monograph, above cited (Pal. Soc. vol. for year 1858), on the Iguanodon.

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[1] "The anterior four teeth are rather smaller than the others; and this is especially true of the first tooth. The anterior edge of the crown of each of these teeth slightly overlaps the posterior edge of the crown of its predecessor."—Huxley, loc. cit., p. 5.

Four or five teeth may have occupied the alveolar interspace between the foremost of the series of ten maxillary teeth and the second tooth from the premaxillary one, *i* (Pl. I, fig. 9). Sixteen teeth of the pattern characteristic of the upper molars of *Iguanodon* would thus occupy the extent of the alveolar border of the upper jaw preserved behind the pointed tooth(*i*). The maxillary is broken away behind such sixteenth molar. The small Iguanodon may, therefore, have resembled the large one, in number or 'formula,' as in the characteristic and peculiar generic pattern, of its teeth. The arrow (10) points to the tooth which is the subject of the magnified view (fig. 10). A comparison of this figure with a similar magnified view of an upper molar of *Scelidosaurus* ('Monograph of a Fossil Dinosaur,' &c., Pl. V, fig. 3[1]) shows the teeth of the two genera to be modifications of the same type. The exterior surface of the crown in *Scelidosaurus* (Pl. II, fig. 21) has a median and two marginal longitudinal elevations or ridges. The marginal ones diverge with the expansion of the crown, and end in points at its extreme breadth, rather more than half way between the base and apex of the crown. This apex and the points of the marginal ridges define a triangle, the converging sides of which are notched or serrate. The hollows between the medial and marginal ridges are smooth in *Scelidosaurus,* the anterior hollow is usually ridged in *Iguanodon.* In this genus the 'secondary' ridges are more feeble than the primary ones, and are plainly the seat of variety, as in the instances above cited. The upper molars of the small Iguanodon (Pl. I, figs. 9, 10) of the present Monograph exemplify the rule of the generic type: the first-cited figure of the two former Monographs shows the variety more approaching the type of the geologically older Dinosaurian (*Scelidosaurus*).

The molars of the Purbeck Dinosaur (*Echinodon,* Pl. II, fig. 22) repeat the pattern of those of *Scelidosaurus,* but the marginal serrations, being more numerous and relatively smaller, more resemble the serrations which Professor Huxley states "are so characteristic of the teeth of Iguanodon."[2]

The tooth, which I have referred, with probability, to the *Hylæosaurus,* shows the shape of crown on which the Scelidosaurian and Iguanodontal patterns have been superinduced; it expands from the base to two lateral angles, whence the sides converge to a third apical angle. If the converging borders of the terminal half of the crown had originally been notched or serrate, those projections had been worn away by use, in the tooth figured ('Monograph on the Fossil Reptilia of the Wealden Formations: Genus *Hylæosaurus*' in the Palæontographical Society's volume for 1856[3]). I may remark, also, that this tooth is a mandibular one, and that a nearer approach to the serrident type may have been shown in the maxillary teeth of the *Hylæosaurus.* Howsoever this may prove to be, the conformity of cranial structure, as of fundamental tooth-type, between *Scelidosaurus, Echincdon,* and *Iguanodon,* now exemplified by the small skull (Pl. I, fig. 9), makes it convenient to associate the genera in a section of *Dinosauria,* which may be termed '*Prionodontia,*' *i. e.* serrident, or saw-toothed.

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[1] Pal. Soc. vol. for year 1859.

[2] Loc. cit., p. 5.

[3] P. 21.

In this family the skull exhibits a more generalised type of structure than in the existing *Crocodilia* and *Lacertilia.*

The short, square, massive character of the cranium, and the greater extent of ossification of the rest of its walls, are retained in modern *Crocodilia ;* but the majority of the characters, as the double or divided external nostrils, the divided frontals, the relatively large orbits, the pterygoids divaricated by intervening basi-sphenoidal pterapophyses, and the separated palatines, are characters retained by modern Lizards. In the majority of existing Lacertian genera, however, the nasals form a single bone, and the premaxillaries are confluent anteriorly. These bones retain their parial condition in *Crocodilia* as in *Prionodontia.*

The position of the portion of lower jaw—left mandibular ramus—preserved in the block of matrix with the skull, precludes the procedures of exploration requisite for detection of teeth or germs of teeth, with any regard for the safety of the rest of this unique specimen, although the temptation is great, in reference to the alleged absence of an Iguanodontal characteristic, namely, the serrations of the free edge in the teeth of this specimen. Not that the allegation has any real value as to the generic character of the Saurian so represented; since it is plain that the remnants of the crowns of the upper molars are not such as could show the Iguanodontal serration if it had existed, the apical part being wanting where alone, as a rule, the crown is marginally serrate in the upper molars of *Iguanodon Mantelli.* In this species, moreover, the serrations are more numerous, and affect a relatively greater extent of the margins of the crown in the teeth of the lower jaw than in those of the upper. Hence it might be expected that the mandibular teeth of the small species from the Cowlease Wealden would apply a decisive test, on the assumption that the absence of marginal serrations—all other Iguanodontal characters present—was decisive against a generic relationship with Iguanodon.

Mr. Fox has kindly transmitted to me the portion of the left mandibular ramus, 1 inch 7 lines in length, with a depth of 7 lines, where entire, which is the subject of figs. 8—11 in Pl. II. It includes the sockets and fangs of eight teeth, so closely set as to have necessitated the overlapping arrangement of the crowns, according to the Iguanodontal type, the hind margin of the anterior tooth covering the outer side of the fore margin of the tooth behind, in the lower as in the upper jaws. The proportion of transverse to fore-and-aft diameters of the fractured bases of the mandibular teeth (fig. 8) in this specimen is also Iguanodontal, suggestive of a bruising function. These eight teeth occupy an alveolar extent of 1 inch 3 lines.

The outer surface of the ramus (ib., fig. 9) is divided into an upper and lower facet by a low, obtuse, prominent angle or ridge extending horizontally, and giving the greatest thickness to that part of the jaw; a series of five vascular or neuro-vascular foramina extends a little above this ridge. The structure of the outer surface of the ramus, exhibited by the larger jaw of a young Iguanodon, also discovered by Mr. Fox, in the same Wealden deposits of the south-west coast of the Isle of Wight, closely accords with that shown by the present specimen (compare 'Monograph on the Fossil Reptilia of the Wealden,' Supplement No. 3, Pal. vol. for 1862, Pl. X, fig. 4, with fig. 9, Pl. II, of the present Monograph).

In like manner the inner surface of the smaller mandibular fragment (ib., fig. 10) shows a gentle convexity lengthwise and an almost level surface vertically, broken by a longitudinal groove near the lower border.

Concluding that, as in *Iguanodon,* the germs of successional teeth would lie on this side of the roots of the broken ones which had been in use, and that such germs would have the 'lanceolate and acuminate' portion of the crown, yielding the required test of conformity or otherwise in regard to marginal serration, I removed the inner (splenial) plate at parts which exposed three such germs (Pl. II, fig. 11, *a, b, d*), each demonstrating the character in question.

The inner side of the crown is traversed longitudinally by the submedial primary ridge, the coronal margin anterior to which shows four acute serrations, with grooves continued from their intervals some way down the surface. The extreme fragility of these precious evidences checked further attempts to expose more of that surface. My interpretation of the characters of the mandible and mandibular teeth, so far as they are exhibited by this specimen, is, that they demonstrate a reptile of the genus *Iguanodon.*

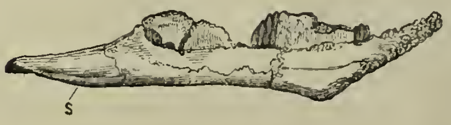
If the specimen belong to a full-grown individual, the greater relative size and the smaller number of the coronal serrations show it to belong to a distinct species of *Iguanodon,* for which the name of its discoverer is deservedly to be retained.

Still may remain the question whether, in the numerous successions of teeth which would ensue during the acquisition of the magnitude of *Iguanodon Mantelli,* the number of serrations might not be increased in greater proportion than the increase of the size of such serrations. That would be the sole modification needed to make them specifically as well as generically the teeth of *Iguanodon Mantelli.*

Of the above-described mandibular fossil Mr. Fox writes:—"This jaw was found within a yard of the skull. They were both in a mass of mud that had slided down from the cliff, and was being gradually washed away by the sea."

What is wanting in the exposed portions of the tooth-germs in the above specimen, viz. the continuation of the marginal serrations, of smaller size, upon the ridge bending from the margin at the broadest part of the crown upon the inner surface of the narrowing basal part of the crown, is fortunately supplied by an almost entire lower molar of *Iguanodon Foxii* (Pl. II, figs. 12—17), which came from a slab of Wealden stone containing a portion of a right mandibular ramus (Woodcut, fig. 1), with the symphysis, *s*, confined to the lower border of the sloping end (as at 5′, fig. 1, Pl. I); also a few ribs, a caudal vertebra of the pattern of those figured in Pls. VIII and IX

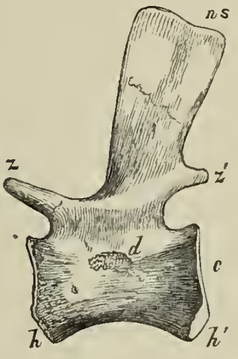
Fig. 1.



of the 'Monograph' on the Iguanodon of Pal. vol. issued for year 1854, and also "a distal phalanx of one of the toes." "I cannot tell," writes Mr. Fox, "where I have the bone itself, but its shape is exactly like that in *Iguanodon Mantelli*, very little curved in a downward direction, and rather broad.[1] In the little paper box, along with the fragment of jaw, you will find one very small tooth, quite perfect,[2] that came out of this slab in dressing."[3] This slab was found in the fallen cliff, about 150 yards east of "Barnes High," directly fronting the den of my *Polacanthus*, which I dare say you will remember seeing. The skull and broken jaw were found about 60 yards further eastward."[4]

In the accompanying Woodcut, fig. 2, of the caudal vertebra, nat. size, of *Iguanodon Foxii*, are added letters of reference corresponding with those on the figure of a caudal vertebra of *Iguanodon Mantelli* above quoted. The anterior or cervical vertebræ show the modification of the front ball and hind cup ('Monogr. on Wealden and Purbeck DINOSAURIA,' Part II, 1855, Tab. I, figs. 3, 4). If the sacral vertebræ should show the broad under surface, as in *s* 4, Tab. III, *Monogr. cit.*, a corresponding variability of vertebral shape in the same skeleton will characterise the present small kind of *Iguanodon* as it does the large kind.

FIG. 2.



The tooth (Pl. II, fig. 12) is 5 lines in length in a straight line; it is moderately curved, with the convexity (as the teeth *in sitû* above described show) towards the inner surface of the jaw, the sculptured surface of the crown having the same aspect. The length of the fang is 3 lines, that of the crown is 2 lines, but the apex of this has been broken off. The breadth of the crown is $2\frac{2}{3}$ lines; the thickness of its base $1\frac{1}{2}$ lines. The fang tapers to its implanted end, which is hollow and filled with matrix, subcircular in form, $\frac{1}{2}$ a line in diameter; the dentinal wall is here very thin. The fang expands towards the crown, chiefly in the antero-posterior direction, and is shorter on the outer concave than on the inner convex side, the coronal enamel descending rather lower on the outer side. The inner side of the fang is broader and less convex across than the outer side, towards which the fang seems to be, as it were, rather pinched in.

The outer side of the crown (ib., fig. 17, magn.) begins with a feeble rise of the enamel from the level of the fang, such rise describing a slight convexity downward; this side of the crown is gently concave lengthwise, more strongly convex across; it is relieved by low ridges continued down from the apices of the chief serrations, most of them subsiding before gaining the basal line. The finer serrations on each margin of the crown, where it bends in from its broadest part, are conspicuous. Minute, short, irregular, longitudinal, linear risings of the enamel may be seen with the pocket lens in part of the interspaces of the longer and plainer ridges. The crown expands to its extreme fore-and-aft breadth about one third of its length from the fang.

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[1] The shape and proportions of the ungual phalanges vary in the toes of the fore and hind feet in *Iguanodon Mantelli.*

[2] Letter received 4th February, 1870.

[3] Ib. ib.

[4] Letter above cited. The skull and broken jaw are the subjects of figs. 9 and 9 *a*, of Pl. I.

The enamel on the inner side of the crown (ib. fig. 15, magn.) begins by a like definite rise from the level of the fang, but this runs straighter across before bending up to the margins of the expanding basal part of the crown. The continuation to the hinder border is more prominent and its termination is more abrupt, giving a slightly angular contour to that border, and making the surface of the crown between the border-ridge and the primary longitudinal ridge a little concave transversely. The basal rising subsides more quickly and completely upon the anterior border, which describes a gentle convex curve, and does not rise so as to render the inner surface of the crown between it and the primary ridge concave. Thus, the inner and outer sides of the crown being determinable by their difference of sculpturing, the fore and hind borders are shown by the above specified characters, and the detached tooth can be referred, as in the case of those of the larger *Iguanodon,* by like characters to its own ramus or side of the jaw; this, in the present tooth, is the right one. The inner side of the crown of this tooth of *Iguanodon Foxii,* as in the lower teeth *in sitû,* has one chief median primary longitudinal ridge, increasing in strength from its origin at the basal rising of the enamel to the apex of the crown. On the front facet a short secondary ridge begins, next the primary one, near the apex of the crown, and terminates in the point or 'serration' next to that of the primary ridge. Another secondary ridge begins at the base of the crown, and runs nearly parallel with the primary one. The margin of the crown, anterior to this ridge, shows the usual smaller serrations. On the hind facet two secondary ridges commence at the up-bent part of the basal one, run parallel with the primary ridge, gaining in prominence and breadth, and terminate in the two stronger serrations behind the chief or apical one. Smaller serrations mark the hind border of the crown between the above and the end of the basal ridge.

Thus, all the complexities giving the generic characters of the lower teeth of *Iguanodon* are here manifested, as are those of the upper teeth in the skull (Pl. I, figs. 9, 10). The following differences from the larger teeth of *Iguanodon Mantelli* are of specific value: the defined rise of the basal border of the coronal enamel on both the outer and inner sides of the tooth, especially the latter; the relatively larger size and smaller number of the marginal serrations; the larger relative size and more definite median position of the primary longitudinal ridge.

The latter character, however, is reached in the range of variety to which the teeth of *Iguanodon Mantelli* are subject, as may be seen in the anterior 'acuminate and lanceolate' tooth in the Purbeck Iguanodon (Pl. I, fig. 8 *b*), and in the figs. 10, 15, 17, Plate VII ('Monograph on the Genus Iguanodon,' Supplement No. 2, Pal. vol. for 1858), exemplifying the characters of the upper and lower teeth of *Iguanodon Mantelli* and some of their varieties, due to age, wear, and position in the jaw.

From the above facts I conclude that the fossils discovered by Mr. Fox, and figured in Pls. I and II of the present Monograph, afford the much-needed exemplification of the cranial structure in the genus *Iguanodon,* and that they contribute to supply characters of the serrident family of *Dinosauria* which were not given in the fossil skull of *Scelidosaurus Harrisonii,* figured in Pls. V and VI of the Monograph on that Liassic Dinosaur, Pal. Soc. vol. for year 1859. The importance of this addition to the knowledge of Dinosaurian structures induces me to recapitulate and enforce the passing remarks, offered in the course of my descriptions, on statements which, if true, would leave such addition still a desideratum.

Serrations of the free edge of the crown, affirmed to be "*so* characteristic of the teeth of *Iguanodon*" (Huxley, *ut supra*, p. 5), are not in any degree characteristic of that genus. They are present in the teeth of older *Dinosauria* as of contemporary genera. The Liassic *Scelidosaur* and the Purbeck *Echinodon* alike manifest the modification. The true generic dental characteristic of *Iguanodon* is the superaddition to marginal serration of ridged and grooved sculpturing of one of the surfaces of the crown of the teeth ; to wit, the outer one in the upper teeth, the inner one in the lower, the sculpturing being in so broad and definite a style that the ridges can be defined and distinguished. This character, combined with marginal serration, in the molars of the small Dinosaur in question, and this other character of the overlap of the expanded crowns in the one direction above described, are now submitted to impartial Taxonomists as the ground of the reference of the subject of the present section (§ 2) to Conybeare's genus.

So singular an anomaly in the arrangement of a molar series as the reversal of the order of overlapping at its two extremes might well support a generic distinction, but would need clear and indisputable demonstration for acceptance. *Iguanodon Foxii* affords no real ground for the ascription of such an anomaly.

As little does the fossil discovered by Mr. Fox support the assertion that its teeth have " no trace of the serrations on the free edge of their crown."

Prof. Huxley seems at one time to have been open to the evidence of the true character of the teeth in the unique skull from the Isle of Wight Wealden. But its discoverer had expressed his belief[1] that it might belong to a young Iguanodon, or to a new small species of that genus;—like the skeleton in which I had previously pointed out Iguanodontal characters.[2] So, in 1869, Prof. Huxley writes:—" A more critical comparison, however, has convinced me that the teeth of this reptile are perfectly distinct from those of the great Wealden Dinosaurian " (*ut supra*, p. 6). My own scrutiny, made in no critical spirit, but simply to find out the true state of the case, leads me to affirm these teeth to be specifically distinct, but not generically, from those of *Iguanodon Mantelli.* What the meaning of his term ' perfectly ' may be, as predicated of this distinction, the author quoted nowhere defines.

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[1] ' Proceedings of Sections, British Association,' Norwich, 1868.

[2] ' Monograph on the Fossil Reptilia of the Wealden and Purbeck Formations—Dinosauria (Iguanodon),' Palæontographical Society's volume for year 1854, p. 2, Pl. I.

In a subsequent Monograph on the parts of "other skeletons of the animal in the same locality," I may test the grounds of the ascription of the tibia and fibula of *Iguanodon Foxii* to the ischium and pubis, and of the hypothesis of its bird-like bipedal progression.

In concluding the present Monograph I would express the deep obligations under which Palæontology is under to the persevering explorations carried on, in brief intervals of leisure, by the Rev. W. Fox, M.A., in the locality which has benefited by his judicious and benevolent spiritual care and supervision.

[APPENDIX TO SUPPLEMENT NO. V MONOGRAPH ON *IGUANODON FOXII*, OW.]

SINCE the foregoing pages went to press, and long since the plates were completed and printed off, some additional observations have been recorded on specimens acquired from Mr. Fox's locality, which have been adduced in support of the title of my *Iguanodon Foxii* to generic distinction. The most important and decisive is that of my experienced fellow-contributor to the Monograph of the Palæontographical Society, Mr. BOYD DAWKINS.[1] *Hypsilophodon*, it appears, has seven digits in each fore-foot, and five developed ones on each hind-foot, whilst *Iguanodon* has but five digits on each fore-foot ('Monogr. Wealden Reptilia,' Supplement No. 4[2] (*Iguanodon*), 1872, Pl. III), and three developed digits on each hind foot (Ib. ib., Supplement No. 1[3] (*Iguanodon*), 1858, Pl. I). He justly, therefore, cites the distinction between *Hipparion* and *Equus* as warranting, or "sufficient for," the adoption of the same taxonomic distinction between *Hypsilophodon* and *Iguanodon*. It was unnecessary to remark (as the learned Society addressed by Mr. B. D. well knew) that two additional developed toes, with hoofs, are present in both fore and hind feet of the Miocene Horse, which toes are represented by splint-like rudiments of the metapodial elements in Pliocene and Modern equines, like the digit I in the above-cited plate of the Iguanodon's foot-skeleton.

Other observations, by Mr. HULKE, have not the same weight as those on the shape of the unequal phalanges of the fore-foot,[4] with me as those of Mr. Boyd Dawkins, seeing that some of the sacral vertebræ of the *Iguanodon*, those, *e.g.* marked *s* 4 and *s* 5 in the specimen of sacrum figured in Pl. III of my 'Monograph on Wealden Reptilia,' Part II[5] (*Iguanodon*), 1855, "are cylindroid and rounded below."[6] Such character might well be extended in a smaller species, but would not lead me to found thereon a generic distinction and name.

Moreover, in the series of eight vertebræ of which "the three last are firmly anchylosed, and the seventh and eighth form part of the sacrum," Mr. Hulke admits that "they are constricted in the middle, and their transverse processes, which spring from the junction of two vertebræ, are bent backwards, joining the dilated outer end of the transverse processes of the next vertebra, including a large subcircular loop."[7] This description might have been taken from the type example of the sacrum of *Iguanodon Mantelli*, figured in the Pal. Society vol. for 1855, above cited; and it adds to the satisfaction I feel in the additional knowledge of the osseous structure of the great herbivorous Dinosaur, which we may inferentially derive from the additional or better preserved parts of the smaller species; but which light it is sought to obscure by the *Hypsilophodon* curtain.

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[1] "Proceedings of the Geological Society of London," No. 273, November 19, 1873, 8vo (p. 2 of 'Abstracts').

[2] Palæontographical Society's volume for year 1871.

[3] Volume for year 1856.

[4] 'Quart. Journ. Geol. Soc.,' No. 116, June 25th, 1873, p. 528.

[5] Volume for year 1854.

[6] Proceedings, Nov. 19th ('Abstracts,' p. 2).

[7] Ib., ib., p. 1.

I have a strong belief and expectation that when specimens of the palatal structure of *Iguanodon Mantelli* are obtained they will resemble those of *Iguanodon Foxii*, figured in my Pl. II of the present Monograph, 'proved' and marked for 'Press' in June, 1873. The 'stout body' of the pterygoid is there shown in fig. 5 (*at* 24); the posterior process (*s*) joining the large 'pterapophysis' or basisphenoidal fork (*t*); the root of the branch (*a*), which Mr. Hulke[1] terms the 'quadratic process' = my 'tympanic process,' and the extension of the outer concave border to join the 'ectopterygoid' (*c*); also the separation, medially, of both pterygoid and palatines. Such, I repeat, may be expected to be, in the main, the palatal character of the great herbivorous Dinosaur. That expectation is further and strongly supported by the significant correspondence between *Iguanodon Mantelli* and *Iguanodon Foxii* in the characteristic and peculiar relations of the teeth to the jaws. "As in *Iguanodon Mantelli* the outer wall of the tooth-groove sends inwards partitions, which practically separate the teeth from one another, and must have afforded them a very firm support; but I doubt if these partitions actually reached the inner wall and became confluent with it."[2] I have no doubt, from the shape and length of the root or fang of the lanidriform tooth (Pl. II, figs. 19, 20, of the present 'Monograph') that it was "contained in a distinct separate socket." The difference, therefore, in the mode of implantation of teeth in the same jaw, as in the shape of vertebræ in the same sacrum, and in the shape of unequal phalanges in the fore and hind feet, are characters common to both *Iguanodon Mantelli* and *Iguanodon Foxii*.

R. O.

December 4th, 1873.

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[1] 'Abstracts of Proceedings,' p. 1.

[2] 'Quart. Journ.' (June, 1873), p. 525.

PLATE I.

Genus IGUANODON.

FIG.

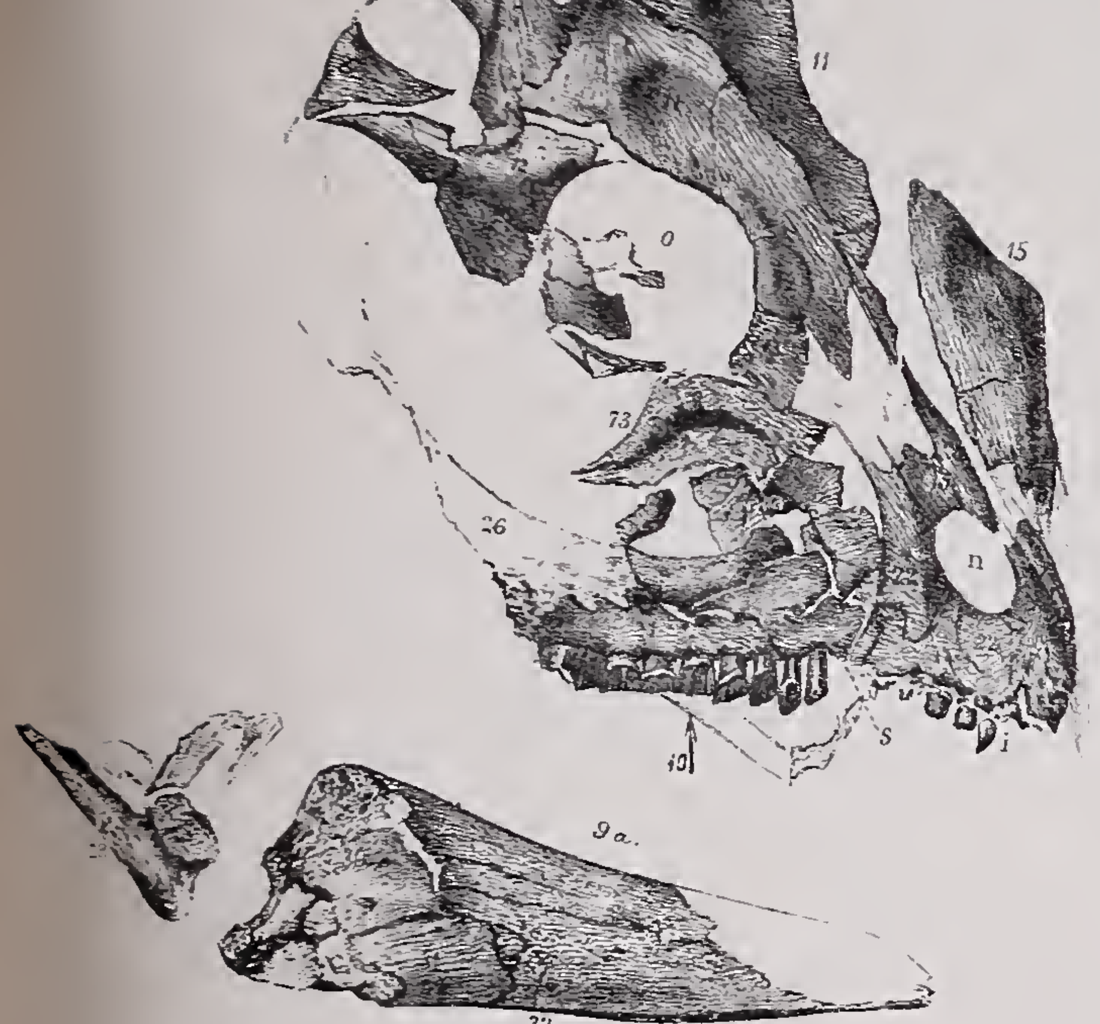
1. Inner side-view of the dentary element of the right mandibular ramus, *Iguanodon Mantelli;* nat. size.
2. Anterior surface of a worn upper molar of a younger *Iguanodon Mantelli.*
3. Inner surface of the same tooth.
4. Outer surface of do.
5. Posterior surface of a lower molar of the same *Iguanodon Mantelli.*
6. Inner surface of the same tooth.
7. Outer surface of do.
8. Inner side-view of a portion of the right mandibular ramus of a younger *Iguanodon Mantelli;* nat. size.
9. Major part of the skull of *Iguanodon Foxii;* nat. size.

9 *a.* Portion of left tympanic and mandibular ramus of the same skull; nat. size (drawn without reversing).

10. Outer side-view of a worn, right, upper molar of the same skull; magn. 5 diams.

Figs. 1—7, from the Wealden Clay of Sussex, are in the Collection of S. H. Beckles, Esq., F.R.S., F.G.S., &c. Fig. 8, from the Middle Purbeck of Swanage, is in the Collection of A. J. Hogg, Esq. Figs. 9, 9 *a*, 10, from the Wealden of the Isle of Wight, are in the Collection of the Rev. W. Fox, M.A., of Brixton, in that island.

Fig. 9.



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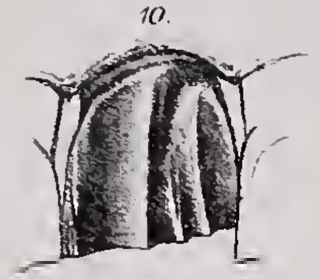

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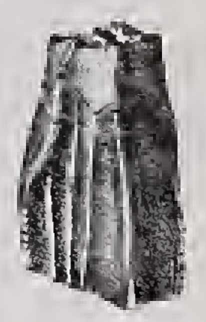

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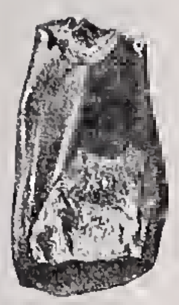

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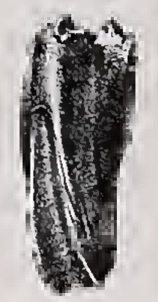

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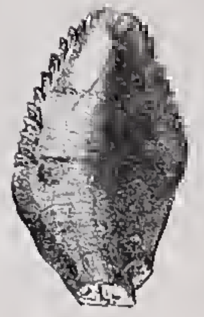

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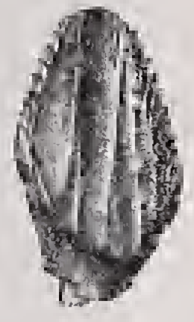

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Fig. 8.

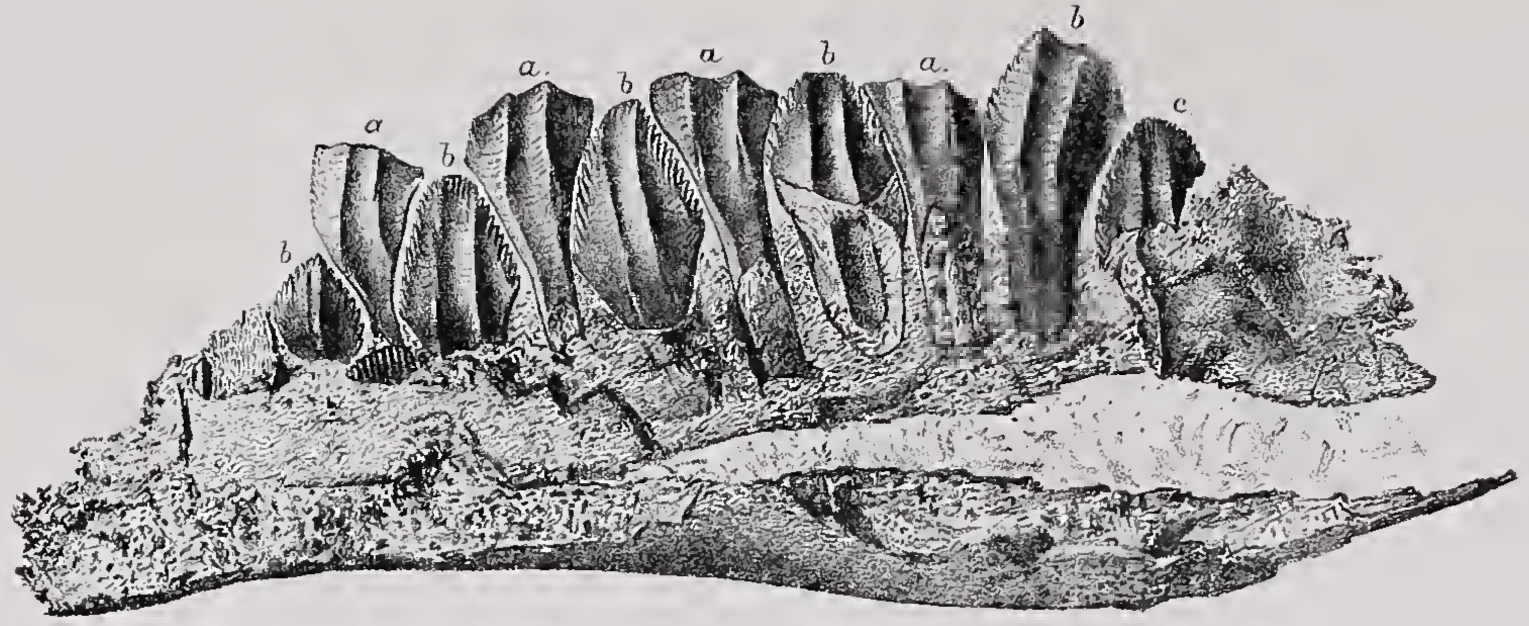


Fig. 1.

C.L. Griesbach del. et Lith.

Mintern Bros imp.

IGUANODON MANTELLI.

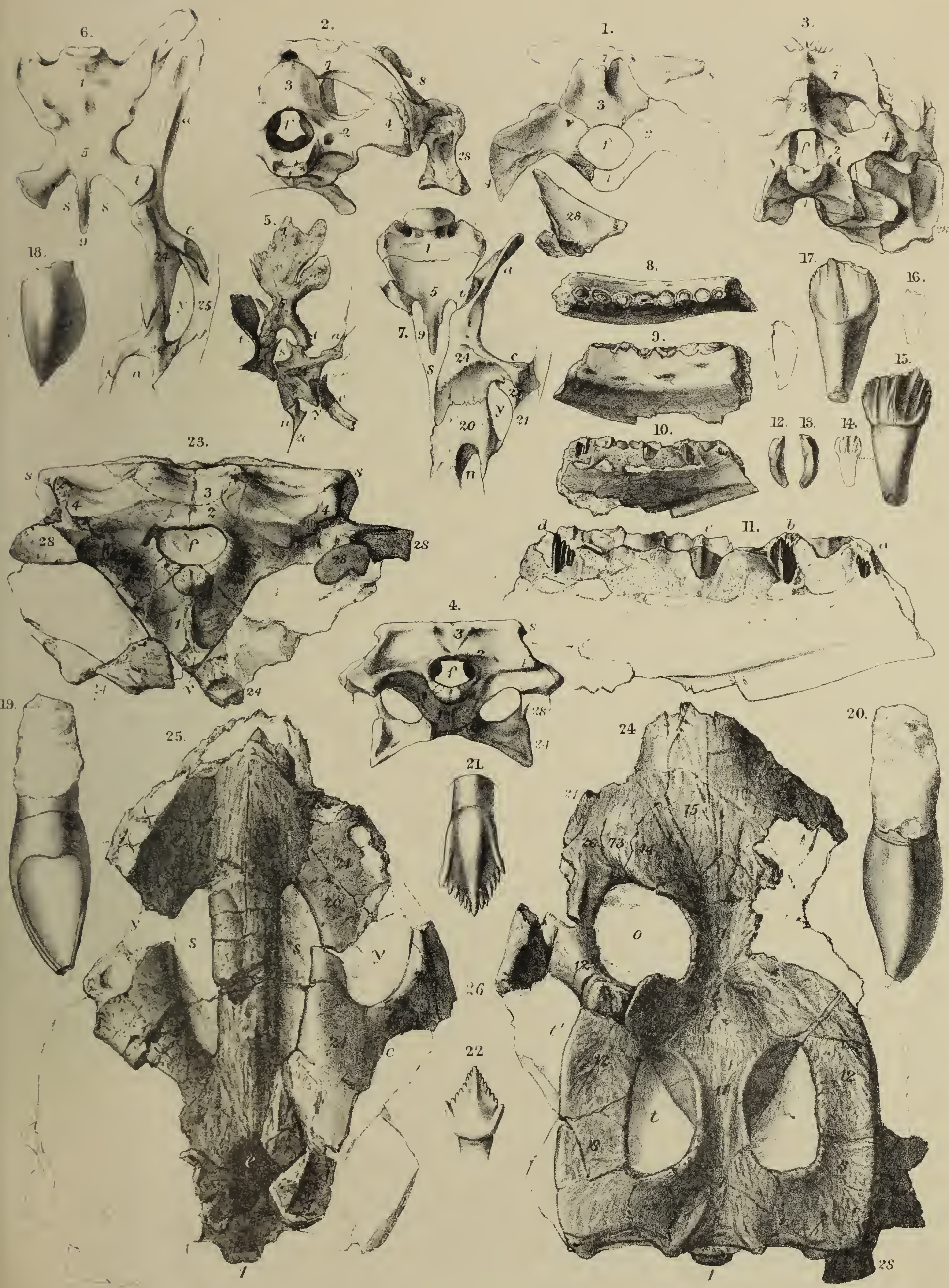
PLATE II.

Genera IGUANODON and HYLÆOCHAMPSA.

FIG.

1. Occipital surface of skull, *Iguanodon Foxii.*
2. Do. *Varanus salvator.*
3. Do. *Iguana tuberculata.*
4. Do. *Crocodilus acutus.*
5. Part of the base of the skull, *Iguanodon Foxii.*
6. Do. *Varanus salvator.*
7. Do. *Iguana tuberculata.*
8. Portion of right mandibular ramus, upper view, *Iguanodon Foxii.*
9. Do. outer side view, do.
10. Do. inner side view, do.
11. Do. do., magn. 2 diams., do.
12. Mandibular tooth, fore side, *Iguanodon Foxii.*
13. Do. hind side, do.
14. Do. inner side, do.
15. Do. do. magn. 2½ diams., do.
16. Do. outer side, *Iguanodon Foxii.*
17. Do. do. magn. 2½ diams., do.
18. Crown of upper laniariform tooth, *i*, outer side, magn. 5 diams., *Iguanodon Foxii.*
19. Upper laniariform tooth, inner side, half nat. size, *Iguanodon Mantelli.*
20. Do. outer side, do. do.
21. Upper molar, outer side, magn. 2 diams., *Scelidosaurus Harrisonii.*
22. Lower molar, inner side, do. *Echinodon Becklesii.*
23. Occipital surface of skull, nat. size, *Hylæochampsa vectianus.*
24. Upper surface of skull, do. do.
25. Under or palatal surface of skull, nat. size, do.

The fossils here figured, with the exception of figs. 19, 20, 21, 22, are from the Wealden of the Isle of Wight, and are in the Collection of the Rev. W. Fox, of Brixton, in that Island.



C. L. Griesbach del. et lith.

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MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

WEALDEN AND PURBECK FORMATIONS.

SUPPLEMENT No. VI.

PAGES 1—7.

CROCODILIA (HYLÆOCHAMPSA).

[WEALDEN.]

BY

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FOREIGN ASSOCIATE OF THE INSTITUTE OF FRANCE,
ETC. ETC.

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SUPPLEMENT (No. VI)

TO THE

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF

THE WEALDEN AND PURBECK FORMATIONS.

(HYLÆOCHAMPSA.)

ORDER—*CROCODILIA.*

Genus—HYLÆOCHAMPSA, *Owen.* (PLATE II of SUPPLEMENT No. V, figs. 23, 24, 25.)

THE subject of the present 'Supplement' was discovered by the Rev. W. Fox, M.A., in the Wealden of the south-west coast of the Isle of Wight. It is the hinder part of a skull of a small or young Crocodilian, showing the occipital surface (Plate II, fig. 23), the upper openings of the temporal fossæ (ib., fig. 24 *t*) with the orbits (*o*); and so much of the palate (ib., fig. 25) as permits of instructive comparisons with that seat of divers modifications in other *Reptilia.* A few sockets of teeth are shown at the hind end of both right and left maxillary bones.

These indicate the teeth to have been relatively as large as in *Goniopholis;* and, although it is hazardous to conjecture the shape of the crown of a Crocodilian tooth from the cylindrical root, as indicated by its socket, yet it seems to me probable that the teeth of the present small Crocodilian resembled more those of *Goniopholis* [1] than of *Suchosaurus*[2] or of *Poikilopleuron.*[3]

The outer surface of the cranial bones shows a different pattern of sculpture from that in *Goniopholis;* instead of small circular pits there are short irregular ridges, which, at some parts, the postfrontals, for example, have a tendency to diverge from a reticulate centre; a number of short ridges and clefts radiate from the raised part of the border of the temporal outlet; but all these accentuations of the surface are rather feeble.

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[1] 'Report on British Fossil Reptiles,' 8vo, Part II, 1841, p. 69.

[2] Ib., ib., p. 67.

[3] Ib., ib., p. 84.

As I know of no corresponding specimen of a skull of any Wealden Crocodilian like the present, and as it offers generic modifications of parts which are comparable with Crocodilians of older and newer formations, I propose to describe the specimen as representing a new genus and species under the name of "*Hylæochampsa vectiana*."[1]

The occipital surface (Plate II, fig. 23), excluding therefrom the tympanics, 28, and pterygoids, 24, is of a triangular form, with the base upward; the apex is pierced by the foramen, *v*. The breadth of this surface, taken at the mastoidean angles, 8, 8, is, to so much of the vertical diameter as includes the foramen, *f*, as three to one. The basioccipital, 1, contributes the middle four fifths of the condyle, the upper angles of which hemispheroid tubercle, due to the exoccipitals, are broken off. The centre of the condyle is feebly impressed; it projects, and is, as it were, sub-pedunculate. The basioccipital curves from the condyle forward and downward, then descends vertically to the foramen, *v*, and is ridged along the mid-line. The extent of the occiput below the foramen magnum, *f*, exceeds the part above the foramen. The exoccipitals, 2, are the largest elements of this cranial segment; they meet above the foramen, excluding the superoccipital, 3, therefrom for an extent of nearly three lines. The suture appears to be continued upward through the superoccipital, 3; but this may be due to fracture. The superoccipital develops a tuberosity at each upper angle, near its junction with the mastoid, 8. Each exoccipital swells at its outer border into two tuberosities, representing the paroccipitals of *Chelonia*, and contributing to the articulation for the tympanic, 28. The direction of the bilobed paroccipital border, 4, is oblique from above downward and inward. The tuberosity forming the angle of the mastoid, 8, projects distinct from the upper paroccipital one, 4.

In the relative extent of the paroccipital tuberosities and in the direction of their border *Hylæochampsa* resembles *Teleosaurus*, and differs from *Crocodilus*, in which the masto-paroccipital border extends from above downward and outward (ib. fig. 4), making the greatest breadth of the occipital surface to be at the paroccipitals, not at the mastoids.

There is no vacuity between the mastoid and superoccipital; a linear suture, slightly concave upward, alone divides them on the occipital surface.

The articular surface of the tympanic, 28, projects as usual, backward, beyond the plane of the occiput; the medial half only of that surface is preserved in the present fossil; it is almost vertical and very slightly convex.

The upper platform of the cranium behind the orbits (Plate II, fig. 24) is subquadrate, with the anterior angles rounded off. It is perforated by the pair of upper temporal openings, *t*, which are oblong-ovate, with the outer border almost straight, the inner one curved, and with the hinder or basal border slightly raised; the anterior border is depressed and continued upon the side of the cranium proper, forming the inner wall of the temporal fossa. A flat surface of bone (8, 12), equalling the breadth of the temporal opening, lies exterior to it; a narrower concave tract (11) divides the openings; the posterior surface (7) is broader than the lateral ones.

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[1] Gr. ὕλη, wood or weald; χάμψα, an Egyptian name of the crocodile. The specific name relates to the locality of the fossil.

In *Teleosaurus* and allied genera (e. g. *Metriorhynchus, Teleidosaurus, Steneosaurus, Pelagosaurus,* &c.) the upper temporal openings are relatively larger and the surrounding flat tract of bone is of less extent than in *Hylæochampsa,* which herein more resembles the tertiary and modern *Crocodilia,* although the form of the openings is teleosauroid.

The general form of the upper cranial surface posterior to the orbits resembles, in *Hylæochampsa,* more that in *Crocodilus, Metriorhynchus,* and *Pelagosaurus,* than that in *Teleosaurus cadomensis* and in *Gavialis,* in which latter the breadth exceeds the length.

The orbits in *Hylæochampsa* (Pl. II, fig. 24, *o*) are circular and better defined by the post-frontal (12) from the lateral outlets (*t'*) of the temporal fossæ than in *Crocodilus,* and herein they more resemble the orbits in *Teleosaurus;* but they are less horizontal than in *Tel. cadomensis,* and incline less to the vertical position than in *Tel.* (*Pelagosaurus*) *temporalis;* their outline is obliquely upward and outward. The prefrontal (14) and lacrymal (73) swell out a little anterior to the orbit, whence the maxillary (21) and nasals (15) continue to form the upper jaw. This recalls the character of that part of the skull in the Gavial rather than in the Crocodile.

These modern or procœlian representatives of the order *Crocodilia* differ from the *Lacertilia* in the greater extent or degree of ossification of the palate.

The 'pterygo-maxillary vacuity'[1] is large, and is bounded, as in Lizards (Pl. II, figs. 6 and 7, *y*), by the pterygoid (24), the ectopterygoid (25), the palatine (20), and, in most genera, *Iguana,* e. g., by the maxillary (21). But the 'palato-maxillary' vacuity[2] (figs. 6 and 7, *n*) between the vomer, maxillary, and palatine, does not exist in *Crocodilia;* nor is there a trace in that order of an 'interpalatine vacuity.'[3] The 'interpterygoid' vacuity in *Lacertilia*[4] appears to be represented by the much smaller opening which serves as the 'palato-naris,' or hinder orifice of the nasal air-passages in modern Crocodilian genera.[5]

In his description of the Caen Gavial (*Teleosaurus cadomensis,* Geof.) CUVIER indicates a large vacuity, more advanced in position than the hinder nostril of modern Crocodiles, and more resembling the 'interpterygoid vacuity' of Lizards (Pl. II, fig. 7, *s*). This he regarded in the Caen Gavial as the 'palato-naris.'[6]

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[1] See my 'Anatomy of Vertebrates,' vol. i, p. 157, fig. 98, c, y; "grand trou palatin" of CUVIER, 'Ossemens Fossiles,' 4to, tom. v, pt. ii, p. 133, pl. vii, fig. 4 *r*; also "trou ovale assez grand," p. 259, pl. xvi, fig. 3, *Varanus niloticus.*

[2] 'Anat. of Vertebrates,' tom. cit., fig. 98, D, *n*.

[3] Ib., ib., fig. 98, D, *m*.

[4] Ib., ib., fig. 98, D, *s*.

[5] Ib., ib., fig. 98, C, *n*.

[6] "La fosse nasale postérieure;" described as "très-grande," and marked with the letter *s* in fig. 4, plate vii, 'Ossemens Fossiles,' tom. cit.

The smaller and more posterior orifice, resembling the 'palato-naris' of *Crocodilus* and *Gavialis*, and which De Blainville and Bronn affirmed to be the true hinder nostril in the Teleosaurs, Cuvier calls "le trou des artères," and marks with the letter *t* in pl. vii, tom. cit.

The real nature of this foramen in the Teleosaurs is pointed out in my paper "On the Eustachian Canals in Crocodiles,"[1] and the accuracy of Cuvier's determination of the 'palato-nares' in the Teleosaur, is now accepted.[2]

In some Teleosaurians (*Tel. temporalis*, Bl., *Pelagosaurus typus*, Bronn) the 'palato-naris,' instead of being broader than long, as in *Tel. cadomensis*, is narrower and is produced forward into a point, on the same transverse parallel as the pterygo-maxillary vacuities, which are thus reduced in size and, as it were, pushed aside.

In *Hylæochampsa* (Pl. II, fig. 25) the vacuity (*y*) on each side of the bony palate is formed or bounded behind by the pterygoid (24) and ectopterygoid (25) and in front by the palatine (20), and probably by a small part of the maxillary (21), though here a portion of the antero-external part of the boundary is broken away. But sufficient remains to show that the vacuity is natural and is homologous with the "grand trou palatine" in *Teleosaurus cadomensis*, and with that called "grand vide palatine" or "trou palatine postérieur" by Eudes-Deslongchamps in *Teleosaurus temporalis* (*Pelagosaurus typus*); consequently with those which I have termed 'pterygo-maxillary' and symbolised by the letter *y* in my 'Anatomy of Vertebrates,' loc. cit. The vacuities in the interspace between the two 'pterygo-maxillary' ones, bounded externally by the pterygoids and palatines, answer to the "fosse nasale postérieure" of Cuvier in *Teleosaurus cadomensis*,[3] and to the "grande fosse ptérygoïdienne, qui limite en avant les arrière-narines" of Eudes-Deslongchamps in *Teleosaurus temporalis*;[4] consequently, also, to that which I have called 'interpterygoid' and symbolised by the letter *s* in *Iguana*.[5]

It is plain that the palatal or posterior opening of the nasal passages offers no trustworthy homological character in *Reptilia*. It is anteriorly situated in *Chelonia* and *Lacertilia*, where those passages are vertical or nearly so; it is at the hindmost part of the bony palate in modern Crocodiles, and in a more advanced position, though still in the hinder half of the palate, in the mesozoic or 'amphicœlian' Crocodiles. In each of these cases it has a distinct anatomical conformation. In *Chelonia* and most *Lacertilia* (*Varanus*, e. g.) its boundary includes parts of the vomer (13), palatine (20), and maxillary (21);[6]

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[1] 'Philosophical Transactions,' 1850, p. 521, pls. xl—xlii.

[2] E. d'Alton and H. Burmeister, 'Ueber der Fossile Gavial von Boll in Wurtemburg,' &c., 8vo, plates in fol., Halle, 1854, in which the small hinder foramen is called "die vereinigten Mundungen der Eustachischen Röhren und gewisser Sinusse im Innern der Ossis occipitis."

[3] Tom. cit.

[4] 'Notes Paléontologiques,' 8vo, 1869, p. 146, pls. ix—xxiv, vi.

[5] Op. cit., fig. 98, D.

[6] Op. cit., fig. 98, B.

in *Iguana* it includes, with the same bones, also a part of the premaxillary; in *Crocodilus* proper it is wholly surrounded by the pterygoids; in *Teleosaurus* the palatines combine with the pterygoids to complete it anteriorly.

With regard to the opening answering to the hinder nostril in *Teleosaurus*, we find in *Varanus* that the halves of the divided vomer also contribute to bound or form the pointed anterior prolongation of the vacuity,[1] in the formation of which, as the pterygoids take the most constant and always the chief share in *Lacertilia* and *Chelonia*, and as the vacuity so bounded does not in these reptiles serve as the hinder or palatal opening of the nostrils, the term 'interpterygoid' appeared to me to be most conveniently applicable.

In the skull of the *Varanus niloticus* figured by Cuvier[2] the presphenoid is prolonged so as to seem to divide the 'interpterygoid vacuity' into a pair; the point of the bone, however, in nature inclines upward, and does not join anteriorly either the palatine or vomerine bones. In the larger monitor (*Varanus indicus*) and in *Iguana* the presphenoid (Pl. II, figs. 6 and 7, 9) has a like relation to the interpterygoid vacuity (ib., *s*), but is not so far produced.

Von Meyer, in his figure of the base of the skull of *Belodon Kapffi*,[3] represents the interpterygoid vacuity as divided by a longitudinal production, apparently, of the pterygoids, the lateral parts or plates of which form with the palatines the outer border of such vacuity. The homologues of the 'pterygo-maxillary vacuities' are much reduced in size, are external and posterior to the 'interpterygoid' openings, and are exclusively formed by the pterygoid and ectopterygoid, which, uniting externally to those openings as well as internally, are interposed between the maxillary and the 'pterygo-maxillary vacuity.' Von Meyer, as usual, puts no figures or letters of reference upon the bones and orifices, nor refers thereto by means of such symbols in his text.

Assuming, however, that the usually careful and accurate delineator of fossil specimens has correctly represented the palatal characters of his *Belodon Kapffi*, it offers the nearest resemblance to the characters of that part of the skull of *Hylæochampsa*.

In the proportion of this part of the skeleton of the Wealden Crocodile transmitted to me by Mr. Fox an extent of three inches of the hinder part of the bony palate is preserved (Pl. II, fig. 25). In this extent four vacuities are more or less completely shown; they are in two pairs. Of the medial pair (Pl. II, fig. 25, *s*, *s*) the left is entire, and the right lacks but a small part of its antero-external border; of the lateral pair (ib., *y*, *y*) the left wants a part of its antero-external border; but of the right, only a small part of the inner and hinder border is preserved.

The left pterygoid (24) is entire in its relations to the above vacuities, only the postero-lateral branch (answering to *a*, figs. 6 and 7) being broken off. The external branch (figs. 25, 6, 7, *c*), extends as usual, outward and forward to articulate with the ectopterygoid

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[1] Cuvier, tom. cit., pl. xvi, fig. 3, &c. &c.

[2] Ib., ib.

[3] 'Palæontographica,' zehnter Band, pl. xxxix, p. 227 (1863).

(ib., ib., 25); this abuts by its outer end against the hinder end of the maxillary (ib., ib., 21) and the contiguous part of the malar (ib., ib., 26), the fore part of the pterygoid (24) bounding with the ectopterygoid the hinder half of the pterygo-maxillary vacuity (*y*). The fore part of the pterygoid, continued along the inner border of that vacuity, articulates with the palatine (20), which, with the maxillary (21), completes the fore part of the boundary of *y*. We have thus the homologue of the 'great palatal opening' of CUVIER,[1] and of the 'posterior palatal opening' of EUDES-DESLONGCHAMPS in the *Teleosaurus cadomensis*,[2] which answers to the vacuity *y* in the *Lacertians*, figs. 6 and 7, Pl. II.

The medial pair of openings (Pl. II, fig. 25, *s, s*), bounded externally by the palatines and pterygoids, and internally, as it seems, by medial processes of the same bones, answer to the 'fosse ptérygoidienne' (VI) of EUDES-DESLONGCHAMPS in *Teleosaurus temporalis*,[3] and to the 'fosse nasale postérieure' of CUVIER in the *Teleosaurus cadomensis*.[4] But in *Hylæochampsa* this pterygoid fossa, or posterior nostril, is divided by so strong a longitudinal bony bar that the pair of vacuities might be taken at first sight to answer to the 'grands trous palatins' in the *Crocodilus rhombifer*.[5]

Such a determination is, however, incompatible with the coexistence of the vacuities (*y, y*) in *Hylæochampsa* and the concomitant recession of the maxillaries (21) from the outer boundaries of the openings(*s, s*, Pl. II, fig. 25).

We have thus another and most remarkable modification of the bony palate to add to those which have led that acute observer EUGENE EUDES-DESLONGCHAMPS to remark, in reference to the extinct *Crocodilia* of the Caen Oolite and other Mesozoic localities, "chaque espèce présente des modifications particulières."[6]

But although it may be admitted that the pair of medial openings (fig. 25, *s, s*) answer to the single medial opening (CUV., t. c., Pl. VII, fig. 4, *s*) in *Teleosaurus*, it does not absolutely follow that they served in *Hylæochampsa* the office of palato-nares. It might be contended that the small single orifice at the mid-line of the extreme hind border of the bony palate (ib., *e*) fulfilled that function, as the similarly sized and situated orifice performs in recent *Crocodilia*. The still smaller orifice (fig. 23, *v*) placed at the hind surface of the skull might in that case be homologized with the median Eustachian outlet,[7] and not with the vascular foramen,[8] in *Crocodilus*.

It should, however, be borne in mind that the true hinder nostril in procœlian

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[1] 'Ossemen's Fossiles,' tom. cit., p. 133, pl. vii, fig. 4, *r*.

[2] 'Notes Paléontologiques,' p. 139, pl. xi, fig. 3, VII.

[3] Ib., ib., pl. xii, fig. 10, VII.

[4] Tom. cit., p. 133, pl. vii, fig. 4.

[5] Marked *h* in fig. 2 of plate iii of the 'Ossemens Fossiles,' tom. cit., and marked *y* in 'Anat. of Vertebrates,' tom. cit., p. 157, fig. 98, c.

[6] Op. cit., p. 147.

[7] "On the Communications between the Tympanum and Palate in the *Crocodilia*," *ut supra*, pl. xl, fig. 1, *e*.

[8] Ib., ib., *v*.

Crocodiles is divided by a pterygoid partition; although CUVIER makes the absence of this division, or inconspicuousness of the septum, a character of the skull of procœlian Gavials.[1] *Hylæochampsa* may show this partition in an exaggerated degree, and the orifices *s*, *s*, and not the orifice *e*, would be the hinder nostril.

Whatever alternative may commend itself to competent Palæontologists, the palatal characters which distinguish *Hylæochampsa* from all other known Reptiles, recent or fossil, are unaffected.

I have had no opportunity of studying the palatal characters in *Goniopholis*, *Suchosaurus*, or any other Wealden Crocodile than the subject of the present Monograph.

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[1] "La cloison qui divise les narines ne se montre pas à leur ouverture postérieure." 'Oss. Foss.,' tom. cit., p. 106.

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MONOGRAPH

ON

THE FOSSIL REPTILIA

OF THE

MESOZOIC FORMATIONS.

PART I.

PAGES 1—14; PLATES I & II.

PTEROSAURIA (PTERODACTYLUS).

[GAULT—LIAS.]

BY

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ETC. ETC.

LONDON:
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MONOGRAPH

ON THE

ORDER *PTEROSAURIA.*

HAVING in former Monographs on extinct volant Reptiles defined species (*e. g. Pterodactylus compressirostris*, *Pter. Cuvieri*, &c.)[1] from the Upper Chalk, and others (*e. g. Pterodactylus macronyx*) from the Lower Lias,[2] I propose to add to the present Monograph a brief account of evidences of *Pterosauria* which have reached me from intervening formations of the Mesozoic period.

§ 1. PTEROSAURIA FROM THE 'GAULT' (Plate I, figs. 5 and 6).

I commence with one from the deposit called 'Gault,' at Folkestone, which is intermediate in age between the Upper and Lower Greensands, from the former of which Pterosaurian remains, remarkable for their great size (*Pterodactylus Sedgwickii*, *e. g.*), have been described and figured in the Society's volumes.[3] Examples of the winged order of Reptiles from the present formation have hitherto been very scanty. The first that has been submitted to my examination is the subject of the following description, and represents the undernamed species.

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[1] 'Monograph on the Fossil Reptilia of the Cretaceous Formations,' Order PTEROSAURIA, Palæontographical Society's vol. for year 1851, issued in 1851, p. 80, Pls. XXVII, XXVIII, XXX.

[2] 'Monograph on the Fossil Reptilia of the Liassic Formations,' Order PTEROSAURIA, Pal. Soc. vol. for year 1869, issued in 1870, p. 41, Pls. XVII—XX.

[3] 'Monograph on the Reptilia of the Cretaceous Formations,' Supplement I (PTEROSAURIA), Pal. Soc. vol. for year 1857, issued in 1859, p. 1, Pls. I—III.

A.—*Pterodactylus Daviesii*, Owen.

Symphysis Mandibulæ, and Teeth (Plate I, figs. 5 and 6).

That this fossil, which is figured of the natural size from the lateral (fig. 5) and oral (fig. 6) surfaces, is the fore part of the symphysis of a lower jaw, and not that part of the palate of the upper jaw, is shown by the medial groove in place of the medial ridge on the surface of the bone which was next the mouth, which surface is here on the upper part of the bone and may have served to lodge and facilitate the movements of a cylindrical protrusile tongue. The character of the palatal surface of the upper jaw is exemplified in *Pterodactylus Cuvieri* (Monogr. cit., 1851, Pl. XXVIII, fig. 4); in *Pterodactylus compressirostris* (ib., ib., fig. 10); in *Pterodactylus Sedgwickii* (Monogr. cit., 1859, Pl. I, fig. 1 *b*); and in *Pterodactylus clavirostris* (Pl. I, fig. 4, of the present Monograph). The grooved character of the oral surface of the mandibular symphisis is shown in *Pterodactylus Sedgwickii* (Monogr. cit., Pl. I, fig. 2 *b*).

The angle of convergence of the two rami of the lower jaw to the symphysis in *Pterodactylus sagittirostris* (Pl. II, fig. 8) renders it improbable that the sides of that symphysis would run parallel for the extent shown in Pl. I, fig. 6, or that the symphysis would terminate so obtusely. Moreover, the five pairs of sockets, with bases of teeth, in the fossil representing *Pterodactylus Daviesii*, indicate teeth of smaller size and closer disposition than in the mandible of *Pterodactylus sagittirostris*. The foremost pair of sockets (ib., figs. 5 and 6, *a*) are less elliptical than the rest. The base of the tooth retained gives an almost circular section; the outlet of the socket is directed more obliquely outward than those of the others, and the crowns of the teeth were, probably, more divaricated in this foremost pair. The sections of the bases of the teeth in the sockets *b*—*e* give a fuller ellipse than the outlet of the sockets themselves. The outer surface of the bone is smooth and even, the upward curve from the under margin of the symphysis is gradual, as shown in fig. 5.

This specimen was discovered in the 'Gault' at Folkestone, by Mr. William Davies, of the British Museum, to whom, in acknowledging much useful assistance, I have pleasure in dedicating the species of Pterodactyle indicated by the present fossil.

§ 2. Pterosauria from the Wealden.

A.—*Pterodactylus sagittirostris,* Owen (Plate II, figs. 1—8).

The type of Cuvier's genus *Pterodactylus* is the species which he calls *longirostris.* The chief generic character is the extreme length of the fourth digit of the fore-limb.[1]

The *Pterodactylus longirostris,* Cuv., is characterised, as the term implies, by long, slender, tapering jaws, armed along their anterior half by numerous long, slender, pointed, separated, and pretty equally distant teeth.

In a general way the portions of mandible about to be described repeat these characters. The mandibular teeth appear to have been about the same in number. Nineteen are reckoned by Cuvier to have occupied the dentigerous part of each mandibular ramus in the type-species;[2] and about as many appear to have armed the same part as *Pterodactylus sagittirostris.*

There is as little trace of condyloid or coronoid processes in the present Wealden Pterodactyle as in the Oolitic longirostral species.[3]

The great and rapid addition to the number of extinct flying Reptiles having the characters of Cuvier's genus *Pterodactylus* has led to its subdivision into several groups or subgenera.

If length of tail with number of caudal vertebræ be accepted as a generic character, those that have that appendage long, and supported by more than thirteen vertebræ, must go to a different group from that including the *Pter. longirostris.*[4]

It is plain that *Pter. sagittirostris* has not the generic dental characters of *Dimorphodon.* It is probable that the symphysial modification which supports the generic name *Ramphorhynchus* was not present.

If the skull of the long- and sharp-jawed Wealden species, or of that from the Upper Chalk which I have described under the name of *compressirostris,* should ultimately be found to offer marked differences in the forms, sizes, and proportions of the narial, orbital, and intermediate vacuities, from those figured by Cuvier in pl. xxiii (op. cit.), it may be deemed requisite to refer them to a distinct pterosaurian group. At present it appears to be convenient to place the sagittirostral and compressirostral with the typal species in the Cuverian genus *Pterodactylus.*

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[1] "Un genre de Sauriens, caracterisé par l'excessif allongement du quatrième doigt de devant, auquel nous avons donné le nom de Pterodactyle."—'Ossemens Fossiles,' tom. v, pt. ii, 4to, 1824, p. 358.

[2] Cuvier, tom. cit., p. 364.

[3] Ib., ib.

[4] In which Cuvier describes the tail as "très-courte, très-grèle, et l'on n'y compte que douze ou treize vertèbres."—Tom. cit., p. 368.

The most striking characteristic difference from that species is the vastly superior size of the seemingly allied Flying Dragons from the British Chalk and Wealden.

In the restoration of the skull of *Pterodactylus compressirostris* (' Monograph on the Fossil Reptilia of the Cretaceous Formations,' 4to, Part I, 1851, Palæontographical Society's vol. for 1851) I ventured to assign to the mandible a length of 14 inches 9 lines (Pl. XXVII, fig. 5). This species was represented by two portions of the upper jaw (ib., Pl. XXVIII, figs. 8, 9, 10) from the Middle Chalk of Kent, the longest portion being 4 inches in length. Of the nearly allied species, represented by three portions of the lower jaw, discovered by Samuel H. Beckles, Esq., F.R.S., F.G.S., in the Hastings series of the Wealden Formation, west of St.-Leonard's-on-Sea, the restoration figured of half the natural size in Plate II, fig. 8, gives a mandible of between 14 and 15 inches in length, and this on the most moderate estimate of the length of the symphysis. In a sketch of a restoration of the jaw, sent to me with the fossils by Mr. Beckles, the length of the symphysis, which he assigns on the basis or analogy of that in Collins's or Cuvier's *Pterodactylus longirostris* gives a total length of 18 inches to the mandible.

The parts obtained by Mr. Beckles are of one and the same lower jaw; and, as an extent of above 2 inches of both rami are maintained by a portion of matrix (Pl. II, fig. 8, *m*) in their natural relative position, the angle of convergence is shown; and this affords a ground for estimating the length of each ramus from the articular surface to the hind part or border of the symphysis at 13 inches, the extent beyond remaining conjectural.

The specimen includes a portion of the left ramus, 9 inches 8 lines in length (of which the anterior 7 inches are given in Pl. II, fig. 1), and two portions of the right ramus, of which the dentary part measures 5 inches (ib., fig. 2) in length, the articular part 2 inches (ib., fig. 5).

The portion of the left ramus includes the dentary element (ib., fig. 1, and fig. 4, 32) with the anterior part of the splenial element (fig. 4, 31). The dentary includes ten of the hinder sockets (ib., fig. 1, 1, 2, 3, 4, 5), of which the five foremost (ib., 6, 7, 8, 9, 10) retain more or less of their teeth. As the number of these which may have been present in the fore part of the jaw is unknown, I count those which are preserved from the hind end of the series forwards. Prolonging the alveolar border according to a moderate estimate of the symphysis, and supposing the teeth to maintain the same intervals, about eighteen may be assigned to each ramus.

The border of the hindmost socket (fig. 1, 1) is not prominent as in the rest, and there is room for doubt whether the oval vacuity which indicates the hindmost tooth really contained one. There is none, however, with regard to the next socket (ib., 2), for this, like the antecedent ones, rises at its outlet above the level of the surrounding part of the bone. It projects from the outer part of the thick, transversely convex, upper border of the dentary, and the course of the cavity shows that the tooth must have inclined somewhat outward as well as forward from the perpendicular. The long diameter of the outlet is in the axis of the jaw, and is 1½ lines (3 m.m.). The short or transverse diameter is 1 line (2 m.m.). The interval between this socket and the one marked 3 is 5 lines (10 m.m.).

The prominent outlet of the socket 3 gives 5 m.m. in long diameter and 3 m.m. in short diameter; these dimensions with that of the interval are repeated to the socket 6, which retains its tooth. The exserted crown of this is 5 lines (10 m.m.) in length; it is conical, acute, gently curved, with the convexity outward and forward.

The apex of the next tooth in advance is broken off, but the basal half is better cleared out of the matrix, giving an antero-posterior breadth of its issue from the socket of 5 m.m.

The teeth in the sockets 8 and 9 are better preserved, and show well the characters of the mandibular ones in the present species.

As in *Pterodactylus longirostris*, the teeth of *Pter. sagittirostris* are subsimilar, divided by nearly equal intervals, these being somewhat wider than in *Pter. longirostris*,[1] relatively shorter than in *Pter. crassirostris*,[2] and more resembling in disposition the indications given by the sockets in the portion of upper jaw of the Cretaceous *Pterodactylus compressirostris*.

The dentary bone supporting the above-numbered teeth is slender and subcompressed; its depth is given in figs. 1, 2, and 4 (nat. size); its thickness is shown in fig. 3.

This is the same at both upper and lower borders, which are similarly rounded off; it is less half way down, owing to the concavity, vertically, of the inner surface of the ramus (ib., fig. 4). The outer surface (fig. 1) is nearly flat; it is traversed lengthwise by a linear impression, which is 5 m.m. below the upper border at the hind end of the proportion of the ramus figured in fig. 1, and is 7 to 8 m.m. below the outlets of the sockets of the teeth 7—9. This linear impression does not indicate a suture.

The ramus slightly increases in thickness, with a gain of convexity externally and a deeper concavity internally (both being in the vertical direction), at the fractured end (ib., fig. 1, 32) nearest the symphysis. At the opposite end the angular element (ib., fig. 4, 30) forms the inwardly prominent lower border; the line between which and the thin flat splenial forms (ib., ib., 31) is clearly sutural.

The portion of the right dentary preserved (Pl. II, figs. 2, 3) answers to that containing the sockets of the teeth numbered 2—9 in fig. 1. There is the same obscurity or lack of demonstration of a socket or tooth behind the socket 2.

The bases of the teeth are preserved in the sockets (numbered 2—6), and partly project from the sockets 2 and 3, but the sockets 7, 8, 9, are vacant.

The articular portion of the right ramus (figs. 5, 6, 7) lacks the prominent, backwardly directed, end of the subangular (30).

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[1] Monograph above cited, Pal. Soc. vol. for year 1851, Pl. XXVII, fig. 1.

[2] Ib., ib., figs. 2 and 3.

The articular concavity (fig. 6, *a*) is transversely extended, chiefly by the production of its inner wall (ib., *b*); its upper boundary is sinuous by a backward production of its mid part; the upper surface in advance of the cavity is smooth and gently convex across it narrows to the ordinary thickness of the ramus about an inch and a half in advance of the articulation. In this extent it shows no trace of a coronoid rising. The inner surface is impressed with a deep longitudinal cavity (ib., fig. 7, *c*).

According to the usual proportions of the upper and lower jaws of Pterodactyles, the premaxillary of the present species must have been twice, or nearly twice, the depth or vertical diameter of the portion of that bone of *Pterodactylus compressirostris* (figured in Pl. XXVIII, fig. 8, of Monogr. cit.). Both upper and lower jaws of *Pterodactylus sagittirostris* must have been broader, less compressed, than in the Cretaceous *Pter. compressirostris.*

The value of a symphysis mandibuli, with its natural anterior termination, like that of the Gault species (*Pterodactylus Daviesii*), is its demonstration of a character determinative of the genus of Pterosaurian. Were it produced into a slender-pointed edentulous style, or 'rostrum,' it would lead to a reference of the species to Von Meyer's genus *Rampho-rhynchus* and Family '*Subulirostres*.'[1] The opposite extreme is shown by the thick obtusely terminated snout, as if it had been cut short, giving the character of the Pterosaurian family *Truncirostres*.[2] The species of this family which have the foremost pair of teeth projecting forward in the upper jaw from the truncate surface at a higher level than the alveolar border form the genus *Coloborhynchus*.[3]

B.—*Coloborhynchus clavirostris*, Owen (Plate I, figs. 1—4).

In two species of these large Pterodactyles from the Cretaceous series, viz. *Coloborhynchus Cuvieri*, from the Middle Chalk of Kent,[4] and *Coloborhynchus Sedgwickii*,[5] from the Upper Greensand of Cambridge, the anterior pair of teeth of the upper jaw project, as in the present species, from the fore part or end of the premaxillary, and are directed forward with a slight downward curve.

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[1] 'Palæontographica,' Heft i, 4to, 1846.

[2] Mihi (*Truncus*, cut short).

[3] κολοβὸς, stunted; ῥύγχος, snout. I have no evidence, and Mr. Seeley gives none, of such departure from the Pterosaurian type of hand as would justify the term *Ornithocheirus* proposed by Mr. Seeley for *Pterodactylus Sedgwicki* in his 'Ornithosauria,' 8vo, 1870, p. 112; or the term *Ptenodactylus* previously proposed by Mr. Seeley for the same Pterodactyle in the 'Index to the Fossils, &c., in the Woodwardian Museum,' 8vo, 1869, p. xvi.

[4] 'Monograph on the Fossil Reptilia of the Cretaceous Formations,' Part I (Palæontographical Society's volume for year 1851), p. 88, Pl. XXVIII, figs. 1—7.

[5] Ib., ib., 4to, Supplement No. I (Palæontographical Society's volume for year 1857), p. 2, Pl. I, figs. 1, *a*—*d*.

In a still larger species (*Criorhynchus simus*[1]), from the Upper Greensand of Cambridge, the foremost pair of teeth project from the under surface of the fore end of the premaxillary, and are directed downward like the following teeth. The fore end of the premaxillary was fortunately entire, showing a flattened or feebly concave tract corresponding to the part bored by the anterior alveoli in *Coloborhynchus*. Some reserve may be prudently entertained as to whether a pair of teeth so anomalously located as in *Coloborhynchus* might not be shed without replacement by successors; and the genus *Criorhynchus* is to be accepted with this reserve, which future discoveries may dissipate. The manifestation by a 'truncirostral' Pterodactyle of the Wealden, and by another from the 'Greensand,' of the produced and unopposed pair of teeth from the front surface of the muzzle, have dissipated the doubts as to its accidental and individual character which legitimately attached to the first specimen, from the Chalk, in which it was observed.

Coloborhynchus clavirostris is, at present, represented by the fore part of the upper jaw of a Pterodactyle (Pl. I, figs. 1—4) from the Wealden, of equal size with *Criorhynchus simus*, from the Upper Greensand, but in which the small anterior pair of premaxillary teeth project from the front surface of the bone, and at a greater elevation above the palate and the sockets of the second pair, than in *Coloborhynchus Cuvieri* or *Colob. Sedgwickii*.

The flattened fore part of the premaxillary (ib., fig. 2) is broader and of less height in *Coloborhynchus clavirostris* before the narrow upper surface (*g*) begins to slope backward to the upper contour of the cranium. The anterior median depression (*h*) is shorter vertically and deeper in *Colob. clavirostris*, where it is below the alveoli of the teeth (*a*, *a*). The convexities (*i*, *i*) on each side of this depression are the fore parts of the sockets of the second pair of teeth, not of the first pair, as in *Criorhynchus simus* (Monog. cit., Pl. I, fig. 3, *a*). The sides of the fore part of the premaxillary in *Coloborhynchus clavirostris* converge, with a slight vertical concavity, to the narrow but obtuse upper border of the skull; the same sides also converge as they recede in a slighter degree, but so that the breadth of the upper jaw behind the sixth pairs of teeth (ib., figs. 1 and 4, *f*, *f*) is less than two thirds the breadth behind the second pair of teeth (ib., *b*, *b*, fig. 4), whence the name *clavirostris* ('club-snout') proposed for the present formidable species of Wealden Pterodactyle.

The fore part of the bony palate, between the teeth of the second pair (ib., fig. 4, *b*, *b*), is transversely quadrate and flat (ib., fig. 4, *k*). Behind this tract the mid third only of the palate retains its level, the two side thirds subsiding (as it seems when looked down upon) into shallow channels, which expand and are continued into the slope rising to the sockets of the fifth (*e*) and sixth (*f*) teeth, leaving the prominent narrow mid tract to represent, as it were, the bony palate; this part has projected below the level shown between the fourth pair of teeth, behind which the thin compact wall is broken away, exposing the widely cellular structure. A similar abrasion affects the upper border of the skull (beyond *i*, fig. 1, Pl. I).

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[1] Ib., ib., 4to, Supplement No. III to 'Monograph on the Fossil Reptilia of the Cretaceous Formations,' PTEROSAURIA, p. 2, Pl. I (Palæontographical Society's volume for year 1858).

The first or anterior pair of teeth (ib., *a, a*) bears the same relations of size to the second (*b*) and third (*c*) pairs as in *Criorhynchus simus*, and may be homologous with the first pair in that species (Monog. cit., Pl. I, fig. 1, *a*) though differing so much in position and direction. In the present specimen of *Coloborhynchus clavirostris* the crown of the first, as of the second, tooth is broken off at the outlet of the socket. The shape of this outlet is a full ellipse (Pl. I, fig. 2, *a, a*); the long diameter, of 8 m.m., is vertical; the short diameter, of 6½ m.m., is transverse. The size and shape of the five following teeth are shown in fig. 1; for, as is common in Pterodactyles, the sockets open obliquely upon the outer part of the alveolar border, and in the present species with a nearer approach to verticality than is usual (compare Pl. I, fig. 1, with Pl. I, fig. 1, of the Monograph of 1858, in the Pal. Soc. vol. issued in 1861).

The present unique evidence of one of the most extraordinary of the extinct order of volant *Reptilia* was discovered by S. H. Beckles, Esq., F.R.S., in the Hastings Series of the Wealden.

§ 3. PTEROSAURIA OF THE KIMMERIDGE CLAY.

A.—*Pterodactylus Manselii*, Owen (Plate I, figs. 10, 11, 12, 20, 21).

Figures 10 and 11 of Pl. I show front (thenal) and back (anconal) views of a mutilated proximal end of the left humerus of this rather small species of Pterodactyle. The reniform articular surface of the head of the humerus (fig. 12, *a*) is somewhat less extended transversely in proportion to its breadth than in a similarly sized species from the Lias (*Pterodactylus Marderi*, ib., fig. 9); its anconal convex border has a bolder curve. There is no indication of a pneumatic orifice on this surface, as in Birds. The pectoral process (*b*, figs. 10 and 11) stand out more abruptly from a less extended base (compare with *b*, figs. 7 and 8, Pl. I).

The proximal end of the first phalanx of the fourth or wing-finger, which is the subject of figs. 20, 21, 21^x, corresponds in size with the portions of humerus above described, near which they were discovered. The olecranoid process (ib., fig. 21, *c*) led observers of the first discovered specimens of this eminently pterosaurian bone to regard it as an ulna. Upon this process is extended part of both the outer and inner concave articular surfaces, so placed as to resemble the two divisions of the 'greater sigmoid cavity' in the human ulna, the curve and depth of which surfaces is thus augmented, and therewith the security of the flexible joint on which the chief movements of the bat-like wing take place. The outer surface, shown in fig. 20, is of less extent, in long diameter, than the inner articulation (ib., fig. 21, *a*); a larger proportion of it is supported by the olecranoid process; and it is better defined along the margin next the longer concavity (*a*). Nevertheless, the smoothness of the surface of the ridge, dividing the concave articulations, suggests that they combined to form a single synovial hinge-joint or 'ginglymus,' limiting the movements of the bones so articulated to one plane, and combining freedom and extent of motion in that plane with great strength of joint. The summit of the olecranoid process in the present specimen shows a rough flattened surface, not a fracture, suggestive of the contact of a sesamoid, probably lodged in the tendon inserted into the phalanx (ib., fig. 21^x).

B.—*Pterodactylus Pleydellii*, Owen (Plate I, figs. 15, 16, 22, 23, 23^x).

The portion of the fossil skeleton of the small species of Kimmeridgian Pterodactyle here figured is the distal half of the left humerus. It shows the generic obliquity and superiority of size of the articular convexity for the head of the radius (ib., fig. 15, *a*,); that for the ulna has suffered fracture, and part of it is lost with the ulnar tuberous ridge; but sufficient remains to show its hemispheroid form, and the mere chink dividing it from the radial condyle instead of the groove which is here seen in Birds. The flexor (?) ridge, leading to the broken tuberosity, extends more forward than in *Pterodactylus Duncani* (ib., fig. 13), and contributes to a deeper concavity above the condyles on the thenal aspect of the distal expansion of the humerus. The transverse ridge behind the condyles is confluent therewith at its extremities, the defining groove not being developed (ib. ib., 16′). The broad shallow canal for the 'triceps' tendon marks the anconal surface of this expansion (ib., fig. 16).

To the same species of *Pterodactyle* may probably belong the proximal end of the smaller example of the first phalanx of the fourth or wing-finger, of which I have given two views in Plate I, figs. 22, 23, and 23^x, to contrast with those of the same bone and part of *Pterodactylus Manselii*. The olecranon process in *Pterodactylus Pleydellii* is relatively longer and more incurved; its apex is not truncate; it is more compressed; has a smaller and lower posterior tuberosity, and a smaller basal tuberosity. The longer concave articulation is similarly extended upon the anterior angle. From the tuberosity at the corresponding or lower end of the shorter concavity a ridge is continued down the bone, giving a triedral form to the shaft as far as it is preserved in this and the previously described specimen (figs. 20, 21). The bony wall of the shaft is thin and compact, the air-cavity large, and in one specimen occupied by crystallised calcite.

The two narrower sides are concave or flat transversely; the broader side is gently convex; it shows, in both species (figs. 21, 23), a longitudinal linear impression, which may indicate a confluent rudiment of a fifth digit.

To the above-described, well-defined, trochlear or ginglymoid joint were adapted the two obliquely disposed condyles of the distal end of the metacarpal of the fourth or wing-finger.

I have pleasure in contributing this mite of testimony to the unremitting attention to the fossil evidences of Kimmeridgian Vertebrates, discovered from time to time on his estates by John C. Mansel-Pleydell, Esq., F.G.S., of Longthorns, Blandford, and to the wise liberality by which they have uniformly been deposited in the National Collection, where inferences and conclusions from their study can be tested by Palæontologists.

C.—*Pterodactylus*, sp. incert.

Two specimens of the carpal bone, provisionally referred in my Monograph of 1857 to a Pterosaurian '*unciforme*,'[1] are figured in Plate I, figs. 24—27. They were both obtained from the "Kimmeridge Clay," at Weymouth, Dorsetshire.

The distal surface of the smaller specimen is given in figure 24; they show the larger concavity (*a*), and the smaller one (*b*), adapted to the two proximal condyles of the metacarpal of the wing-finger. The thenal border of the bone is the thinnest, and is produced at each end into a short process; the anconal border of the bone is thicker, especially where it supports the smaller and outer articular metacarpal concavity.

The proximal surface (ib., fig. 25) is also divided into two principal articulations, but the larger one (*c*) is subdivided into a concave and a flattened facet. The smaller concave surface (*d*) is next the outer and thickest end of the bone.

The subject of figs. 26 and 27 is the homologous bone, and from the forelimb of the same side, but it shows modifications that plainly bespeak its having come from a distinct species of Pterodactyle. The outer subhemispheric concavity of the proximal surface (ib., fig. 27 *d*) is relatively larger, as is likewise the flat facet at the inner part of the larger surface (*c*). The two condylar concavities (*a* and *b*) on the distal facet are more equal than in the larger unciforme.

Both bones exemplify the definite, well-marked, or finished character of the articular surfaces which characterise the bones, especially those of the wing, of the volant Reptile.

I would still be understood to be guided by considerations, not beyond probability, in referring this well-marked bone to the distal row of the carpal series; for I have not yet had the opportunity of studying a Pterosaurian carpus or tarsus in so well-preserved and undisturbed a condition as would enable me, with certainty, to determine the homologies of its constituent bones.

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[1] Palæontographical volume for year 1857, issued in 1859, plate iv, figs. 5 and 6.

§ 4. Pterosauria of the Great Oolite.

A.—*Pterodactylus Kiddii*, Owen (Plate I, fig. 17).

The first phalanx of the wing-finger (fig. 17), referable to this species is somewhat stouter, but about one eighth shorter, than that bone in the *Pterodactylus suevicus*, Quensted,[1] from the Lithographic Slate of Wirtemberg. It indicates a species with a more powerful, though, perhaps, less elongate, wing. The groove for the flexor tendon of the fourth digit, bounded by the prominent thenal extensions of the two articular grooves, is well marked. The extensor process (ib., *c*) has a relatively longer basis than in the Kimmeridge specimens. A rough groove or linear depression beginning about an inch beyond the proximal articulation, and extending as far down the fore or thenal surface of the shaft of the bone, indicates the extensive attachment or insertion of that tendon. The shaft is subtriedral, the anconal side being the broadest; it becomes flattened towards the distal end, which expands unequally towards the ulnar side, and affords an oblong, moderately developed, concavo-convex surface for the second phalanx of the wing-finger.

This bone, from the Stonesfield Oolite, is slightly crushed.

B.—*Pterodactylus Duncani*, Owen (Plate I, fig. 18).

The first phalanx of the wing-finger, referred to the above species, is of the left wing, and is imbedded with the anconal surface exposed in a slab of Stonesfield Slate.

It is from a larger Pterodactyle than the preceding. The extensor process is thicker, but springs from a less extended base, relatively to the length of the bone.

C.—*Pterodactylus Aclandi*, Owen (Plate I, fig. 19).

This species is represented by a still larger specimen of the characteristic wing-bone (fig. 19) in Pterosauria. The olecranoid process (*c*) is shorter in proportion to the breadth and thickness of the proximal end, and the free termination of the process is more definitely marked by a smooth and shallow groove, over which it seems that the tendon of the "extensor alæ" may have glided before its insertion into the strong rough process (*e*).

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[1] "Ueber *Pterodactylus suevicus*," 4to, Tübingen, 1855.

.The second phalanx of the wing-finger (Plate I, fig. 28) may have belonged to a Pterodactyle of the same species or size as the proximal phalanx of the *Pterodactylus Kiddii.* On this hypothesis its proportion of length would resemble that in the *Pterodactylus* (*Dimorphodon*) *macronyx* (' Monograph on the Fossil Reptilia of the Liassic Formations,' *Pterosauria,* Palæontological volume for year 1869, Plate XX). The distal end of the present "Stonesfield" bone becomes triedral by the rise of a ridge from the thenal aspect, extending longitudinally, and enlarging, to near the outer end of the distal oblong articular surface; this is more convex transversely than is the proximal surface. The longitudinal ridge in question afforded insertion to a strong flexor tendon.

§ 5. Pterosauria from the Lias.

I have not yet received any evidence of a Pterosaurian from the "Alum Shales" of Whitby, or any other member of the Upper Lias of our North-Eastern Coast, which represents, by the sum of its palæontological evidence, the "Posidonomyen-Schiefer" of Bavaria. There, however, in the locality of Banz, have been discovered instructive remains of a Pterosaurian, which Professor Quensted refers to my Lower-Liassic genus under the name of *Dimorphodon Banthensis.*

The specimen about to be described, from the Lower Lias of Lyme Regis, is insufficient to give subgeneric characters, and is provisionally registered under the wider generic name.

A.—*Pterodactylus Marderi,* Owen (Plate I, figs. 7, 8, 9).

Of this species is here figured the upper or proximal half of the right humerus (figs. 7 and 8). The head or articular surface (fig. 9) is a narrow, bent, or reniform convexity, with the concave margin toward the thenal side of the bone (fig. 7). The inner and more obtuse end of the articulation, with the tuberosity of that side, is broken away; the outer, narrower, and, in this species, pointed end is lost upon the ridge or upper border of the "pectoral process" (*b*). The expanded part of the shaft, beyond the articulation, is concave transversely on the thenal aspect (fig. 7), convex on the opposite or anconal side (fig. 8), which shows, as usual, no trace of the fossa and foramen characterising that part of the humerus in Birds of flight. The antero-posterior thickness of this part of the bone is less than that of the contracted cylindrical part of the shaft lower down, the section of which is circular.

This humerus, besides being smaller than that of *Dimorphodon macronyx*,[1] has a more straight and slender shaft, which in transverse section is more nearly cylindrical.

B.—*Dimorphodon Macronyx*, Owen (Plate I, figs. 13, 14).

The other Pterosaurian fossil, obtained by Mr. Marder, from the same formation and locality, might well, by its superior size, and more ellipsoid section of the shaft, have formed part of the first long-bone of the wing of the species restored in the 'Monograph of Liassic Pterosauria' of 1870.

The articular surfaces of the humerus in both specimens of this Pterosaurian figured in that Monograph (Mon. cit., Plates XVII, XVIII, 53, 53[1]) were too much crushed and mutilated for profitable description. The present specimen shows instructively the distal articulation.

The surface for the radius presents one uniform convexity, *a*, oblong in shape, and obliquely disposed, extending from the lower part of the radial ridge (*c*), upward, forward, and ulnad; it is almost wholly developed from the thenal aspect (fig. 13), only the lower border of the convexity being visible from the anconal side (at *a*, fig. 14). It is longer and more prominent than the ulnar convexity or condyle. This (ib., *b*) is subhemispherical; its diameter equals the shorter diameter of the radial condyle. The intercondylar fissure is a mere cleft; and tuberous ridges, extending from the condyles, augment the breadth of the distal end of the humerus. The outer or radial one (*c*) is produced forward, bounding there, and in part forming the anterior concavity. The inner or ulnar ridge (*d*) is more distally placed, projecting to a lower level than the condyle (*b*); it is continued upwards with a convex curve, but is not produced forward like the radial ridge.

Both ridges are connected by a narrower one, extending transversely behind the two condyles, from which it is divided by a fossa (fig. *d*, *c*). There is a broad and shallow depression on the back part of the distal end of the humerus for a large "triceps" tendon: there is no anconal depression.

In my description of the articular end of a long-bone of a Pterosaur in the Supplement, No. 1, to the 'Monograph on Cretaceous Pterosauria" (1857), p. 16, Plate IV, figs. 1, 2, 3, I remarked that, "guided by considerations of size, the fragment might form the opposite end of the bone, indicated by the articular ends (Pl. II, figs. 7 and 8), which were referred to the head of the humerus. But I proceeded to remark, 'I am not acquainted with the precise configuration of the distal end of the humerus in any Pterodactyle. From general analogy, however, one should scarcely be prepared to find so feeble an indication of divisions into condyles, an absence of a general convexity, and a presence of a well-defined concavity in one condyle, and as well defined a flattened or feebly concave facet in the other condyle, of the distal end of a humerus" (ib., p. 16). The demonstration of the true characters of this end of the humerus, given in Plate I, figs. 13, 14, and *d, c*, have justified the refusal to regard the articular end of the bone of the large Cretaceous Pterosaur as part of the humerus. Should it prove to be the head of a tibia, what a monstrous flying dragon it would indicate!

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[1] 'Monograph of Liassic Pterosauria,' Pal. vol. for year 1869, pl. xviii, figs. 53, 53 *a*.

There is no part of the skeleton of the Bird that more resembles the answerable bone in a Pterosaur than the humerus. But the following, with other differences pointed out in the previous Monographs, are well marked and, as far as my observation goes, constant.

The pectoral process from the radial side of the proximal expansion of the humerus is relatively longer from base to apex, with a broader, more truncate, or less pointed termination in the flying Reptile: it usually forms a low angle in the Bird.

At the distal end of the humerus of the Bird the oblong radial condyle is usually more pointed anteriorly; the ulnar one is more extended transversely, and the intercondylar cleft is widened to a groove. The outer and inner ridges are not connected by a post-condylar transverse ridge. The olecranial surface is more depressed, and the tricipital tendinal grooves are better marked; but the transverse expansion of the distal end is less in proportion to the breadth of the shaft of the humerus in the Bird than in the Pterosaur.

Other differences in the Pterosaurian humerus, notwithstanding its adaptive development to flight, showing departure from the avian, and approach to the crocodilian, type are pointed out in detail in my Monograph (Palæontological volume for year 1858, issued in 1861, Supplement, No. III, 'Cretaceous Pterosauria,' p. 13, Plate III).

PLATE I.

Mesozoic Pterosauria.

Fig.

1. Left side view of fore end of upper jaw of *Coloborhynchus clavirostris.*
2. Front view of the same specimen.
3. Hind view of ditto.
4. Under or palatal view of ditto.
5. Left side view of fore end of lower jaw of *Pterodactylus Daviesii.*
6. Upper or oral view of the same specimen.
7. Front or thenal view of proximal portion of right humerus of *Pterodactylus Marderi.*
8. Back or anconal view of the same specimen.
9. Proximal end, with the 'head' or articular surface, of ditto.
10. Front or thenal view of proximal portion of left humerus of *Pterodactylus Manselii.*
11. Back or anconal view of the same specimen.
12. Proximal end, with the head or articular surface, of do.
13. Front or thenal view of distal end of right humerus of *Pterodactylus* (*Dimorphodon*) *macroynx.*
14. Back or anconal view of the same specimen.
15. Front or thenal view of distal portion of left humerus of *Pterodactylus Pleydellii.*
16. Back or anconal view of the same specimen. 16′. Articular end of ditto.
17. Front or thenal view of the proximal phalanx of the fourth or 'wing-finger' of *Pterodactylus Kiddii.*
18. Back or anconal view of the proximal phalanx of the 'wing-finger' of *Pterodactylus Duncani.*
19. Outer side view of the proximal phalanx of the 'wing-finger' of *Pterodactylus Aclandi.*
20. Outer side view of the proximal end of proximal phalanx of the 'wing-finger' of *Pterodactylus Manselii.*
21. Back or anconal view of the same specimen; 21*. articular surface of ditto.
22. Outer side view of proximal end of proximal phalanx of the 'wing-finger' of *Pterodactylus Pleydellii.*
23. Back or anconal view of the same specimen. 23′. Articular surface of ditto.
24. Articular surface of carpal bone of *Pterodactylus.*
25. Opposite articular surface of the same specimen.
26. Articular surface of homologous carpal bone of another kind of Pterodactyle.
27. Opposite articular surface of the same specimen.
28. Back or anconal view of second phalanx of 'wing-finger' of a Pterodactyle.

All the figures of the natural size.

The subject of figures 1—4, from the Hastings series of the Wealden, west of St.-Leonard's-on-Sea, Sussex, is in the possession of its discoverer, Samuel H. Beckles, Esq., F.R.S., &c. Those of the following figures are in the British Museum:—5 and 6 are from the Gault at Folkestone; 7, 8, 9, 13, 14, are from the Lias of Lyme Regis, Dorsetshire; 10, 11, 12, 15, 16, 20, 21, 21*, 22, 23, 23′, 24, 25, 26, 27, are from the Kimmeridge Clay, Dorsetshire; 17, 18, 19, 28, are from the Oolitic State, Stonesfield, Oxfordshire.

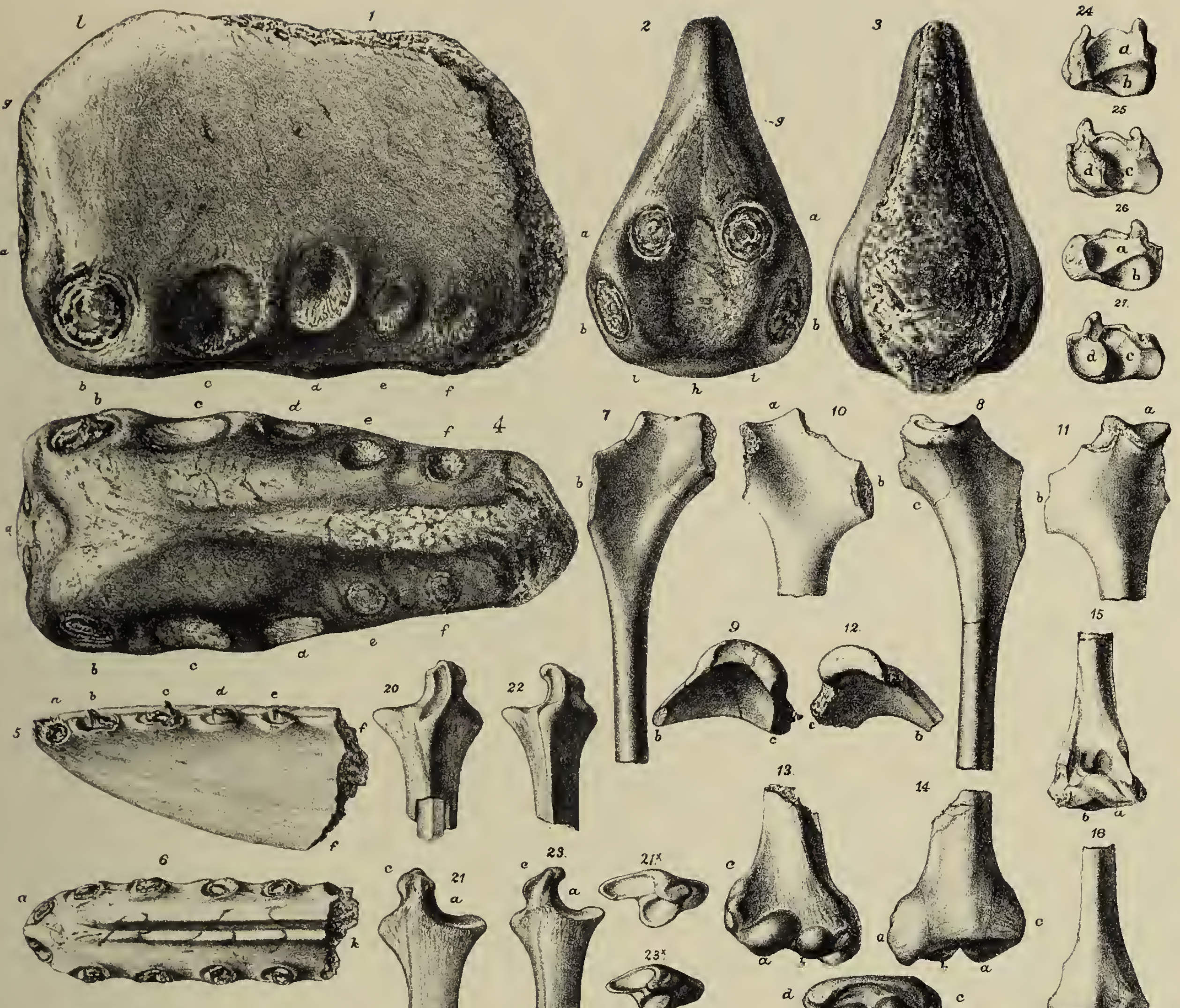

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PLATE II.

MESOZOIC PTEROSAURIA.

FIG.

1. Outer side view of part of left mandibular ramus, with teeth, of *Pterodactylus sagittirostris.*
2. Outer side view of part of right ramus of the same mandible.
3. Upper view of the same specimen.
4. Inner side view of part of the left mandibular ramus of ditto.
5. Outer side view of articular part of the right mandibular ramus of ditto.
6. Upper view of the same specimen.
7. Inner side view of the same specimen.

The above figures are of the natural size.

8. Reduced upper view of the same specimens, with conjectural restoration, in dotted outline, of the form or proportions of the entire mandible of *Pterodactylus sagittirostris.*

This fossil, from the Hastings series of the Wealden, west of St.-Leonard's-on-Sea, Sussex, is in possession of its discoverer, Samuel H. Beckles, Esq., F.R.S.

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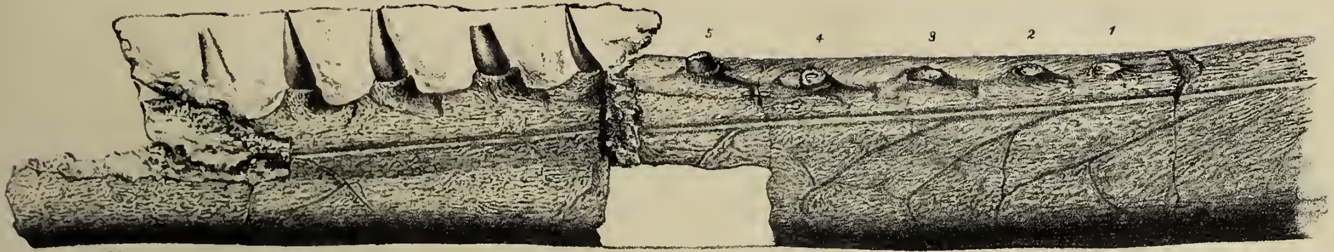

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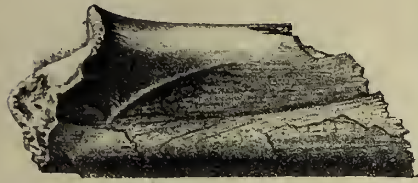

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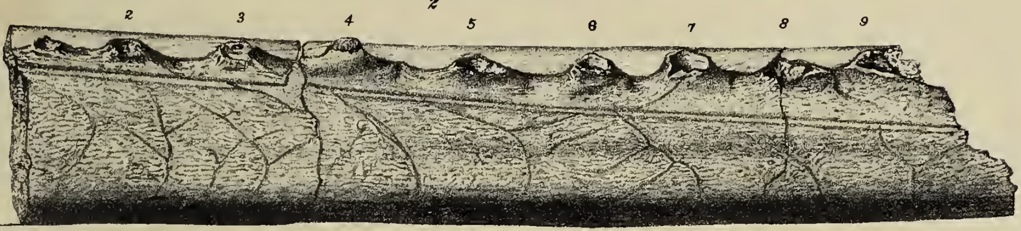

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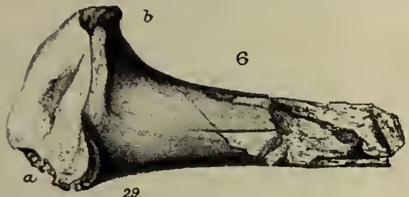

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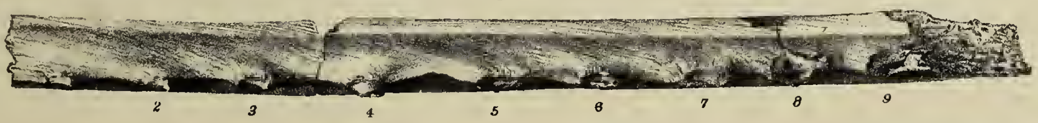

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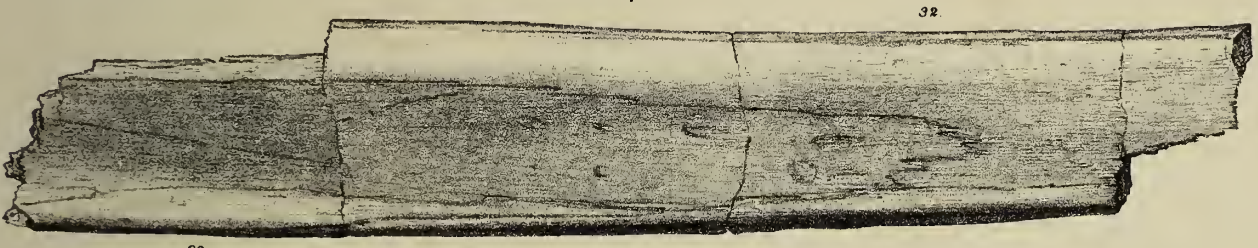

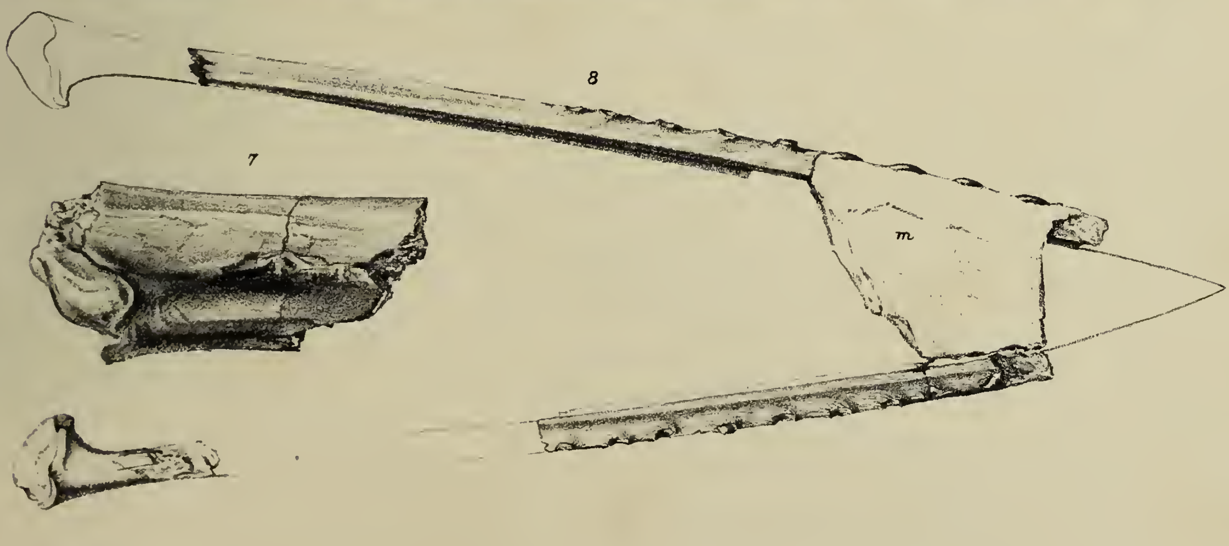

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